G.E.T
ENTRY TEST
SERIES

PIEAS-MS

Physics »

E = mc2
6.6720*10-11 N*m²/kg

G.E.T
Grow-Excel-Train
1st Edition

- » Introduction to PIEAS MS Entry Test 2021
- » MS Physics (SUBJECT PART BOOKLET)
- » According To PIEAS MS (PHYSICS) 2021 Syllabus
- » Most Important Practice MCQ's With Answer Keys.

G.E.T Preparations

https://chat.whatsapp.com/KHSxI0XqeLt2tliOn7EFBs

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How To Ace Your PIEAS MS (Fellowship) Entry Test 2021

Essentials:

- ***Always Believe in Allah*** and yourself. Everything goes the right way. And if you think something is going the wrong way and you can steer it to the right side.

DO IT! But if you find no chance, leave it upon Allah! Everything becomes right!

- ***Respect Time***. Always! Whether it's the time to prepare for PIEAS MS Entry Test 2021, or its time to take tests, or its time to manage your exam. Always keep yourself ahead of time.
- Never under estimate the power of your common sense. Do apply formulae and cramming, but never forget logics.
- Remember ***Rest Is Best for the Test*** and healthy brain resides within a healthy body Always take care of your health.
- Always ***Keep Your Aim In Your Mind***. Revise your purpose of doing what you are doing and what you have to do every night before sleeping.
- ***Serve Your Parents.*** Respect your teachers. Envy your colleagues.
- Work hard and the engineering life waits for you...!

Yes
you
can!

FINAL TIPS BEFORE PIEAS MS ENTRY TEST 2021

- *Have a **Good Dinner on PIEAS MS Entry Test 2021 Night and a Sound Breakfast in the Morning** and you must have a **sound sleep for at least 08 hours before Test** no matter how much course is remaining.*
- *Have a good shower before going for PIEAS MS Entry Test 2021.*
- ***Never read your books in the morning before PIEAS MS Entry Test 2021** as it vanishes your previous knowledge and makes that knowledge a vague one.*
- ***Enter The Exam Hall with Full Confidence,** have chocolates with you, all these things are very helpful in keeping us tension free. You may bring pocket size HAND SANITIZER for your personal use, also please must wear FACE MASK.*
- *First of all sit at your seat quite calmly and satisfactorily and if you feel panic anytime during the exam, **Take 1-2 Long Breaths**, this will soothe you.*
- *Enter the exam hall with the determination that **You Have No Other Option but to become a PIEASIAN, But Once You Leave Exam Hall, and You Have Plenty of Options in Your Life Much Better than to become a PIEASIAN.***

That's everything from our side and we have done to the best of our personal experiences.

Wishing You All A Very Best Of Luck.

Good Luck ☺

Team
G.E.T Preparations

Pakistan Institute of Engineering and Applied Sciences (PIEAS)

Information Leaflet for Postgraduate Admissions

1. Introduction to PIEAS

Pakistan Institute of Engineering and Applied Sciences (PIEAS) is a multifaceted educational institution with academic and training programs being conducted at the highest level in a broad spectrum of disciplines. The breadth of its course offerings is a reflection of the complexity and diversity of the programs of Pakistan Atomic Energy Commission (PAEC), for which PIEAS has been the major human resource development centre since 1967.

PIEAS has been conducting postgraduate degree and certificate programs for scientists, engineers, medical doctors and technicians over the last 50 years. The educational infrastructure that has been created for this purpose is now so extensive that, besides nuclear technology, the institution can pass on to the youth of the nation, the experience in a wide range of specialized fields such as information technology, nuclear medicine, medical physics, materials engineering, process engineering, systems engineering and laser technology.

Postgraduate academic programs at PIEAS also involve R&D works, which frequently are published in international and national journals, conference proceedings and technical reports.

In QS Universities World Ranking, PIEAS was ranked No. 1 in Pakistan for the years 2019 and 2020.
In QS Asian Universities Ranking, PIEAS was ranked No. 1 in Pakistan for the years 2014 and 2015.
PIEAS got adjudged as the Best Engineering Institution in Pakistan by HEC in 2006, 2012 and 2013.

PIEAS has four constituent colleges *[sub-campuses]*, namely:

1. Karachi Institute of Power Engineering (KINPOE-C) at Karachi,
2. National Institute of Biotechnology and Genetic Engineering (NIBGE-C), Faisalabad,
3. Nuclear Institute of Agriculture and Bio Sciences (NIAB-C) at Faisalabad and
4. National Institute of Laser & Optronics (NILOP-C) at Nilore, Islamabad.

2. Introduction to PAEC

Pakistan Atomic Energy Commission (PAEC) is a multi-disciplinary national organization engaged in: (i) development of nuclear power and fuel cycle facilities, (ii) research and development related to nuclear power and applications of radioisotopes in agriculture, medicine and industry, (iii) production of special materials and chemicals, (iv) design and fabrication of sophisticated components and complete units, (v) provision of highly specialized technical services, and (vi) education and training of scientists, engineers, medical doctors and technical staff in specific technical areas of interest.

To fulfil the manpower requirements of the wide variety of institutes, centres, projects and plants under PAEC, it requires outstanding engineers, scientists and medical doctors who are keen to enhance their technical knowledge even further by pursuing MS programs in their relevant fields at Pakistan Institute of Engineering and Applied Sciences, (PIEAS) Nilore, Islamabad and achieve a level of excellence in their subsequent professional careers.

3. Postgraduate Programs at PIEAS

1. PhD / MS Systems Engineering
2. PhD / MS Mechanical Engineering
3. PhD / MS Nuclear Engineering
4. PhD / MS Materials Engineering
5. PhD / MSc Nuclear Medicine
6. PhD / MS Physics
7. PhD / MS Medical Physics
8. PhD / MS Computer Science
9. PhD / MS Process Engineering
10. MSc Radiation and Medical Oncology
11. PhD / MS Radiation Physics
12. PhD / MS Electrical Engineering
13. MS Mineral Resource Engineering
14. PhD/MS Chemistry
15. MS Cyber Security
16. PhD / MPhil Biological Sciences (at NIAB-C)

17. PhD / MPhil Bio-Technology (at NIBGE-C)
18. MS Nuclear Power Engineering (at KINPOE-C)
19. PhD Laser and Semiconductor Physics (at NILOP-C)

Information about admission to the above mentioned postgraduate degree programs is given below. For information about other programs of PIEAS, interested students may visit the PIEAS website \\www.pieas.edu.pk

There are four types of students registered at PIEAS.

1. Regular Students
2. Fellows sponsored by PAEC or other strategic organizations
3. Students sponsored by IT & TELECOM ENDOWMENT FUND

1. **All of the degrees must have been approved by the HIGHER EDUCATION COMMISSION.**
2. **Engineering degrees must also have accreditation by the PAKISTAN ENGINEERING COUNCIL.**
3. **Medical degrees must also have accreditation by the PAKISTAN MEDICAL AND DENTAL COUNCIL.**

4. The Eligibility Criteria for Postgraduate Programs

i. PAEC Fellowship Scheme

For fellowship in the aforesaid MS degree programs, first division is preferably required throughout the academic career. However, one-second division *(≥ 50% marks)* is allowed in academic career at any stage except the final degree. Maximum age limit for MBBS doctors is 32 years and 27 years for all other disciplines as on the reference date mentioned in the advertisement. ***The candidates having BS (4 years)/Master degree in Chemistry, Computer, Geo Physics or Geology must have studied Physics and Mathematics at undergraduate level.***

ii. Students sponsored by IT ENDOWMENT FUND

In order to be eligible for scholarship under IT Endowment, first division is preferably required throughout the academic career provided they meet the pre-requisite course requirements of the degree program to which they are seeking admission. *However, one-second division (≥ 50% marks) is allowed at any stage in the academic career from Matriculation to final degree*. Applicants having third division in academic career are not eligible. However, the Rector, PIEAS only in case of nominees from foreign government/agencies, may relax this condition. There is no age limit for regular students.

iii. Regular Fee Paying Students

In order to be eligible for admission in any of the aforesaid MS degree programs as regular fee paying students, first division is preferably required throughout the academic career provided they meet the pre-requisite course requirements of the degree program to which they are seeking admission. *However, one-second division (≥ 50% marks) is allowed at any stage in the academic career from Matriculation to final degree.* Applicants having third division in academic career are not eligible. However, the Rector, PIEAS only in case of nominees from foreign government/agencies, may relax this condition. There is no age limit for regular students.

Field-wise eligibility in various MS programs for induction is shown in the table given below for **REGULAR FEE PAYING STUDENTS and FELLOWS SPONSORED BY THE PAEC FELLOWSHIP SCHEME.**

5. Selection Procedure for the MS Programs

1. The selection of the applicants as fellows of PAEC is strictly on merit for all Pakistani nationals.
2. Eligible candidates according to the above mentioned criteria will be called for a written test in major cities throughout Pakistan.
3. Those who qualify the test will be called for interview.
4. Admission will be offered on merit based on the results of the written test and interview.

6. Structure of Postgraduate Degree Programs

The duration of all the MS programs is two years. This includes 4 regular semesters of 16 weeks teaching followed by two weeks for terminal examinations, one summer session of 10 weeks and an initial orientation period of about 10 weeks, called the "Zeroeth Semester" in which fundamental concepts are reviewed.

Zeroeth Semester

The fellows are required to qualify a ten-week semester called the "Zeroeth Semester". The students other than fellows are strongly advised to attend the zeroeth semester. It serves to fill some of the gaps in their knowledge of Computing, Mathematics and other areas. It also provides a transition period during which the students become familiar with the teaching methodology and academic environment at PIEAS. **FELLOWS ARE REQUIRED TO ATTEND THESE CLASSES REGULARLY. SUCCESSFUL COMPLETION OF ZEROETH SEMESTER IS MANDATORY FOR FELLOWS FOR THEIR REGISTRATION IN THE FIRST SEMESTER.**

7. Terms and Conditions of PAEC Fellowship

The continuation of the fellowship is contingent upon satisfactory performance, which is adjudged at the end of each semester.

Students winning the fellowship programs will be paid a fellowship of approximately **Rs. 35,000/=** per month with the following benefits:

1. Full tuition Fee-waiver
2. Free indoor medical facility for self

Fellows have to pledge a surety bond to serve PAEC for 5 years after graduation.

8. Prospects after Graduation (for Fellows)

PAEC may offer graduates on fellowship, appointments in the Institutes, Centres and Projects of PAEC after the successful completion of their studies. It is to be noted that the graduates may be posted anywhere in Pakistan. In this regard the final decision rests with the Pakistan Atomic Energy Commission.

On successful completion of MS / MSc studies, the fellows who are selected for appointment in PAEC will be given additional benefit of advance increments and relaxation in promotion as admissible under rules.

9. Terms and Conditions of IT Endowment Fund Scholarship

Admission to only MS Computer Science / MS Cyber Security / MS System Engineering programs is available under this scholarship. The eligibility criterion for this program is given in the table below.

The continuation of the scholarship is contingent upon satisfactory performance, which is adjudged at the end of each semester.

The selected students will be paid a monthly stipend of Rs. 25,000/- with full tuition fee waiver during MS studies.

Fellows have to pledge a bond to serve the country for 5 years after graduation otherwise they will have to pay the bond money as mentioned in the bond agreement.

10. Additional Admission Requirements and Procedures

- The fellows are selected purely on merit.
- The candidates, who expect to complete all the degree requirements such as, final exams and thesis/project by the date of joining PIEAS may also apply.
- The date of joining PIEAS is mentioned in the advertisement published in leading daily newspapers.
- **It should be noted that without final results, the selection is only provisional and would be cancelled for those who do not get first division in final degree examinations.**
- The candidates of MSc (Nuclear Medicine and Radiation & Medical Oncology) whose one year house job training is expected to be completed by the time of joining PIEAS may also apply.
- Applications for admission are invited through advertisement in newspapers/PIEAS website.
- All applicants are required to apply through online admission portal.
- All columns of the application form must be carefully completed. **If any column is left blank or not filled correctly, the application may not be entertained.**
- ***Application processing fee once deposited will not be refunded in any case, therefore before submitting the application, the candidates must make sure that they are eligible for the program for which they are going to apply and also that the program is included in the advertisement.***

Application Processing Fee*

• Application processing fee within due date	Rs 3500/-
• Application processing fee within one weeks after due date	Rs 4500/-

****- Application processing fee is non-refundable.***

The Challan of Application Processing Fee must be deposited in any Askari Bank Branch of Pakistan only. ***There will be no bank service charges for submission of processing fee through any branch of Askari Bank.***

The Application Processing Fee can also be deposited through online mode in Pakistan only. ***There will be Rs. 40/- service charges for online payment of application processing fee.***

Step by Step Application Procedure

- Application submission will be online only. Hard copy applications are not acceptable.
- Go to http://pieas.edu.pk/ and click "Admission" tab
- Create an account and Login to start the online application.
- Fill in and submit online application form. *[Read the instructions carefully]*
- Upload recent passport size color photograph as per the defined standard.
- Upload academic documents.
- Print "**Bank Challan**" for Application Processing Fee.
- Make payment in nearest Askari Bank and upload scanned copy/image of deposited fee slip at PIEAS admission portal.
- Print the "**Call Letter**" (which will be made available after verification of fee through bank).
- Appear for Test at the venue and date mentioned in your call letter.
- Merit List will be placed on PIEAS website within 3 weeks after test.
- Keep visiting your profile on our website for any update before and after Entry Test.

Field-wise Eligibility in various MS Programs at PIEAS for Fellowships

Post Graduate Programs		Pre-Requisite Degree														
		Engineering Disciplines											Physical Sciences			
		Mechanical	Chemical	Metallurgy / Materials	Electrical (Power)	Electrical/ Electronics	Mechatronics	Industrial Electronics	Computer / Software Engg	Mining	Geology	Civil	Physics	Chemistry	Computer	Geology
at PIEAS	MS Nuclear Engineering	√	√		√							√	√			
	MS Systems Engineering					√	√	√								
	MS Electrical Engineering				√											
	MS Process Engineering		√													
	MS Materials Engineering			√												
	MS Mechanical Engineering	√														
	MS Mineral Resource Engineering									√	√			√		
	MS Medical Physics												√			
	MS Physics												√			
	MS Radiation Physics												√			
	MS Chemistry													√		
	MS Cyber Security								√						√	
at KINPOE	MS Nuclear Power Eng.	√	√		√	√		√								

Field-wise Eligibility for IT Endowment Fund Scholarships

Post Graduate Programs	Engineering Disciplines										Physical Sciences			
	Mechanical	Chemical	Metallurgy / Materials	Electrical (Power)	Electrical/ Electronics	Mechatronics	Industrial Electronics	Computer / Software Engg	Mining	Geology	Physics	Chemistry	Computer	Geology
at PIEAS					√			√					√	

11. Regular Students – Fee Structure for MS Programs (subject to revision at any time)

Fee Type	(Rs.)	Category
Admission Charges	15000/-	Once
Re-admission Charges	15000/-	Per re-admission
Library Development Fund	2000/-	Once
Library Security	10000/-	Once, Refundable
Hostel/Transport Conservation Charges	7000/-	Once
Tuition Fee	2300/-	Per credit hour per semester
Thesis and clinical work Fee	30000/- 60000/-	Per semester Per annum for Nuclear Medicine or equivalent thesis/clinical work
Thesis and clinical work Fee	20000/-	Per semester, for Medical Physics, RMO or equivalent thesis/clinical work
Registration Fee	2000/-	Per semester
Examination Fee	2000/-	Per semester
Internet/PERN Fee	3000/-	Per regular semester
	1500/-	Per summer session
Student Club Fee	3000/-	Per regular semester
	1500/-	Per summer session
Transport Charges	11000/-	Per regular semester
Hostel Internet Charges	2000/-	Per regular semester
Degree & transcript Fee	4000/-	Each
Migration Certificate Fee	1000/-	Each
Duplicate Transcript Fee	4000/-	Each
Duplicate Degree Fee	10000/-	Each
Degree/Transcript Verification Fee	500/-	Per copy
Paper Rechecking Fee	1000/-	Per paper
Accommodation Charges for full time students/ trainees	3300/-	Per month for shared accommodation with community bath
	4400/-	Per month for shared accommodation with attached bath
	5500/-	Per month for single accommodation with community bath
	6600/-	Per month for single accommodation with attached bath

- - Fee structure may be revised at any time.

Fee Breakdown for First Semester (subject to revision at any time)

1. One Time Charges (Rs. 34,000/-)
    a. Admission Charges Rs.15,000/- (once)
    b. Library Development Fund Rs. 2000/- (once)
    c. Library Security Rs.10,000/- (once, refundable)
    d. Hostel/Transport Conservation Charges Rs.7,000/- (once)
2. Tuition Fee is Rs.2,300/- per credit hour per semester.
3. Other Miscellaneous Charges (Rs. 10,000/- + Rs. 2,000/- (optional for availing hostel internet facility))
    a. Registration Fee Rs.2,000/- per semester
    b. Examination Fee Rs.2,000/- per semester
    c. Internet/PERN Fee Rs.3,000/- per semester
    d. Student Club Fee Rs.3,000/- per semester
    e. Hostel Internet charges Rs.2,000/- per semester. For those availing internet Connection in their rooms in PIEAS hostels
4. Transport charges Rs.11,000/- per semester. For those availing PIEAS transport
5. Hostel Accommodation Rs.3,300/- per month (shared accommodation).
   (For those availing hostel accommodation in PIEAS hostels).

Description of 1st Semester Fee	MS
Fee excluding hostel accommodation and PIEAS transport.	Rs.71,600/- (for 12 credit hours)
Total fee including Hostel accommodation.	Rs.91,400/-
Total fee including PIEAS transport.	Rs.82,600/-

Note:–

- First semester fee should be deposited online in PIEAS University online account. Fee challan will be made available on admission portal to successful candidates.

Fee Refund Policy

%age of Tuition Fee	Timeline for Refund
Complete refund after deduction of Admission Charges	Up to 7th day of convene of first semester
50% Refund	From 8th – 15th day of convene of first semester
No Refund	From 16th day of convene of first semester

Regular Students – Fee Structure for MS Programs

Fee Type	(Rs.)	Category
Application processing fee (on-line) Application processing fee (on-line) (within two weeks after due date)	3500/- 4500/-	Once, Non Refundable
Re-admission Charges	15000/-	Per re-admission
Library Development Fund	2000/-	Once
Library Security	10000/-	Once, Refundable
Hostel/Transport Conservation Charges	7000/-	Once
Tuition Fee	2300/-	Per credit hour per semester
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Internet/PERN Fee	3000/-	Per regular semester
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	3000/-	Per regular semester
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	11000/-	Per regular semester
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Degree & transcript Fee	4000/-	Each
Migration Certificate Fee	1000/-	Each
Duplicate Transcript Fee	4000/-	Each
Duplicat Degree Fee	10000/-	Each
Degree/Transcript Verification Fee	500/-	Per copy
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No Refund	From 16th day of convene of first semester

Pakistan Institute of Engineering and Applied Sciences (PIEAS)

Written Test Pattern for Intake 2021

IMPORTANT: There will be 60 Subject specific MCQs based questions and the applicant will be given 90 minutes to attempt *.

***NOTE:** *This test pattern has been specially designed for Admissions in 2021 considering the COVID pandemic situation. Follow SOPs and Stay Safe.*

Distribution of Questions will be as follows:

PHYSICS	
RELATED TOPICS	SHARE
CLASSICAL MECHANICS (such as Kinematics, Dynamics, Work and Energy, Gravitation, Central Forces, Lagrangian and Hamiltonian Formalism, Non-inertial Reference Frames)	approx. 20%
ELECTROMAGNETISM (such as Electrostatics, Magneto statics, AC and DC Circuits, Electromagnetic Induction, Maxwell's Equations and Electromagnetic Waves)	approx. 15%
WAVES AND OPTICS (such as Wave Properties, Superposition, Interference, Diffraction, Geometrical Optics, Polarization, Doppler Effect)	approx. 10%
THERMODYNAMICS AND STATISTICAL PHYSICS (such as Laws of Thermodynamics and Their Applications, Statistical Interpretation of Thermodynamics, ensembles, kinetic theory, ideal gases, equation of state)	approx. 10%
QUANTUM MECHANICS (such as Basics Concepts, Schrödinger Equation and its Solutions, Harmonics Oscillator, Hydrogen Atom, Angular momentum and spin, Perturbation theory)	approx. 15%
ATOMIC PHYSICS (such as Rutherford and Bohr models, Atomic Energy levels and Atomic Spectra, Black-body Radiation, X-rays)	approx. 10%
SPECIAL TOPICS (such as Nuclear and Particle Physics, Condensed Matter Physics, Mathematical Methods in Physics, Computational Physics, Special Relativity, Laboratory Methods	approx. 20%
CHEMISTRY	
RELATED TOPICS	SHARE
Analytical Chemistry (Classical Quantitative Analysis, Instrumental Analysis)	approx. 15%
Inorganic Chemistry(Basic Chemistry of Elements, Periodic & family trends, Electronic & Nuclear Structure, Transition Metal / Coordination Chemistry)	approx. 25%
Organic Chemistry (Conversion of functional groups, Reactive intermediated and reaction mechanisms, molecular structure)	approx. 30%

Physics

Subject Part

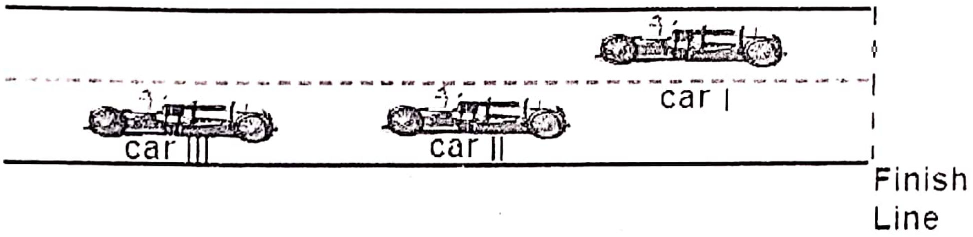
According to Syllabus 2021

https://chat.whatsapp.com/Lo60doaGQxF6mmWK5dCjWK

CLASSICAL MECHANICS

[Kinematics, Dynamics, Work and Energy, Gravitation, Central Forces, Lagrangian and Hamiltonian Formalism, Non-inertial Reference Frames]

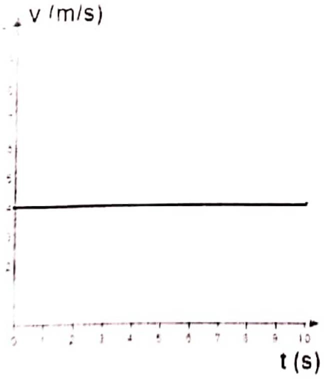
1. A snapshot of three racing cars is shown on the diagram. All three cars start the race at the same time, at the same place and move along a straight track. As they approach the finish line, which car has the lowest average speed?



A. Car I
B. Car II
C. Car III
D. All three cars have the same average speed
E. More information is required

Ans: C

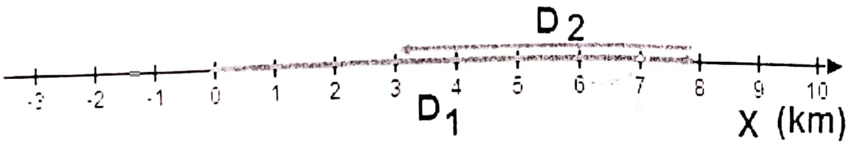
2. The graph represents the relationship between velocity and time for an object moving in a straight line. What is the traveled distance of the object at 9 s?



A. 10 m
B. 24 m
C. 36 m
D. 48 m
E. 56 m

ANS: C

➔ The diagram below illustrates a person who, starting from the origin, walks 8 km east during first day, and 5 km west the next day. Use it to answer questions 3 and 4.



3. What is the net displacement of the person from the initial point in two days?

A. 6 km, east B. 3 km, east C. 10 km, west D. 5 km,

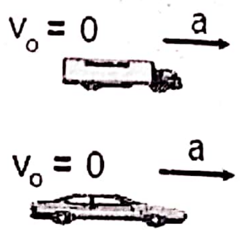
ANS: B

4. What is the travelled distance of the person from the initial point in two days?

A. 13 km
B. 3 km
C. 10 km
D. 5 km
E. 9 km

ANS: A

5. A car and a delivery truck both start from rest and accelerate at the same rate. However, the car accelerates for twice the amount of time as the truck. What is the final speed of the car compared to the truck?



A. Half as much
B. The same
C. Twice as much
D. Four times as much
E. One quarter as much

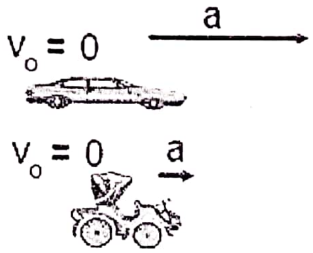
ANS: C

6. A car and a delivery truck both start from rest and accelerate at the same rate. However, the car accelerates for twice the amount of time as the truck. What is the traveled distance of the car compared to the truck?

A. Half as much
B. The same
C. Twice as much
D. Four times as much
E. One quarter as much

ANS: D

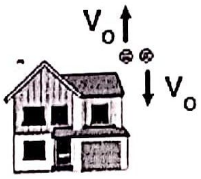
7. A modern car can develop an acceleration four times greater than an antique car like "Lanchester 1800". If they accelerate over the same distance, what would be the velocity of the modern car compared to the antique car?



A. Half as much
B. The same
C. Twice as much
D. Four times as much
E. One quarter as much

ANS: C

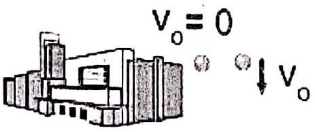
8. Two baseballs are thrown from the roof of a house with the same initial speed, one is thrown up, and the other is down. Compare the speeds of the baseballs just before they hit the ground.



A. The one thrown up moves faster because the initial velocity is up
B. The one thrown down moves faster because the initial velocity is down
C. They both move with the same speed
D. The one thrown up moves faster because it has greater acceleration
E. The one thrown down moves faster because it has greater acceleration

ANS: C

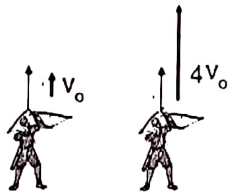
9. A tennis ball is dropped from the top of a tall building. A second tennis ball is thrown down from the same building. Make a statement about the acceleration of each tennis ball.



A. The first ball falls with a greater acceleration
B. The second ball falls with a greater acceleration
C. They both fall with the same acceleration because they stated from the same height
D. The both fall with the same acceleration because they are in a free fall
E. More information is required

ANS: D

10. An archer practicing with an arrow bow shoots an arrow straight up two times. The first time the initial speed is v_0 and second time he increases the initial sped to $4v_0$. How would you compare the maximum height in the second trial to that in the first trial?



A. Two times greater
B. Four times greater
C. Eight times greater
D. Sixteen times greater
E. The same

ANS: D

11. A force acting on a body of mass 7 kg produces an acceleration of 10 ms^{-2}. The acceleration that the same force will produce in a body of mass 9 kg will be

A. 5 ms^{-2}
B. 6 ms^{-2}
C. 6.5 ms^{-2}
D. 7.7 ms^{-2}

ANS: D

12. Two masses 4.5 kg and 3.8 kg are attached to the ends of an inextensible string passes over a frictionless pulley. Its acceleration when both masses are moving vertically will be equal to

$$a = \frac{(m_2 - m_1)g}{m_1 + m_2}$$

A. 0.8 ms^{-2}
B. 0.5 ms^{-2}
C. 2 ms^{-2}
D. 1.5 ms^{-2}

ANS: A

13. When a force acts on a body, it produces an acceleration in the body and will be equal to the rate of change of

A. velocity of the body
B. displacement of the body
C. inertia of the body
D. momentum of the body

ANS: D

14. The acceleration that is produced by a 15N force in a mass of 8 kg will be equal to

A. 1.5 ms^{-2}
B. 1.87 ms^{-2}
C. 2.35 ms^{-2}
D. 2 ms^{-2}

ANS: B

15. A bullet of mass 30 g is fired from a gun with a muzzle velocity $90ms^{-1}$. If its mass is 4 kg then the recoil of the gun will be
A. – 0.34 ms^{-1}
B. 0.54 ms^{-1}
C. – 0.54 ms^{-1}
D. 0.34 ms^{-1}

ANS: C

16. Two masses 7.5 kg and 6.7 kg are attached to the ends of an inextensible string passes over a frictionless pulley. Its tension when both masses are moving vertically will be equal to

A. 50 N
B. 70.7 N
C. 65.6 N
D. 45 N

ANS: B

17.A brick of mass 100 g is attached to a rope 1m long. The brick is rotating in a circle with $5ms^{-1}$ speed. The tension in the rope will be

A. 3 N
B. 2.5 N
C. 4 N
D. 1.5 N

ANS: B

18. The maximum value of friction is

A. limiting friction
B. unlimited friction
C. infinity
D. none of above

ANS: A

19.A wire is stretched by 2 equal and opposite forces 15 N each. The tension in the string will be

A. 30 N
B. 20 N
C. 15 N
D. 25 N

ANS: A

20.A group of interacting bodies on which no external force is acting is known as

A. sexasigmal system
B. isolated system
C. SGS system
D. none of above

ANS: B

21. A gardener pushes a lawn roller through a distance of 20m. If he applies a force of 20kg weight in a direction inclined at 60° to the ground, find the work done by him. ($g=9.8m/s^2$)

a) 400J

b) 1960J

c) 250J

d) 2514J

Answer: B

Explanation: F = 20kg wt = 20×9.8N

s = 20m

$\theta = 60°$

$W = Fs\cos\theta = 20\times9.8\times20\times\cos60°$

W = 1960J.

22. A person is holding a bucket by applying a force of 10N. He moves a horizontal distance of 5m and then climbs up a vertical distance of 10m. Find the total work done by him?

a) 50J

b) 150J

c) 100J

d) 200J

Answer: c

Explanation: F = 10N, s = 5m, $\theta = 90°$

Work done, $W_1=Fs\cos\theta = 10\times5\times\cos90° = 0$

For vertical motion, the angle between force and displacement is 0°.

Here, F = 10N, s = 10m, $\theta=0°$

Work done, $W_2=10\times10\times\cos0 = 100J$

Total work done = W_1+W_2 = 100J.

23. A moving hammer drives a nail into the wood. It has kinetic energy.

a) True

b) False

Answer: a

Explanation: A moving hammer possesses kinetic energy as it is in virtue of motion. A moving object can do work. Therefore a moving hammer drives a nail into the wood.

24. How much mass is converted into energy per day in Tarapur nuclear power plant operated at 10^7 kW?

a) 10g
b) 9g
c) 9.6g
d) 2g

Answer: c

Explanation: Power, $P = 10^7$ kW $= 10^{10}$J/s
Time, t=1day=24×60×60s
Energy produced per day, $E = Pt = 864\times10^{12}$J
$E = mc^2$
$m = E/c^2 = 9.6$g.

25.A machine gun fires 60 bullets per minute, with a velocity of 700m/s. If each bullet has a mass of 50g, find the power developed by the gun.

a) 1225W
b) 12250W
c) 122.5W
d) 122W

Answer: b

Explanation: Mass of the bullets = 60×50 = 3000g = 3kg
v = 700m/s t = 1min = 60s
Power = W/t = (Kinetic energy)/t = 12250W.

26. For a collision to occur, the actual physical contact is necessary.

a) True
b) False

Answer: b

Explanation: A collision is said to occur between two bodies, either if they physically collide against each other or if the path of one is affected by the force exerted by the other. For a collision to take place, the actual physical contact is not necessary.

27. A satellite revolves very near to the earth surface. Its speed should be around?

a) 5km/s
b) 8km/s
c) 2km/s
d) 11km/s

Answer: b
Explanation: Near the earth's surface,
$v_0=\sqrt{gR}=7.2km/s$
Approximately 8km/s.

28. The value of escape velocity on a certain planet is 2km/s. Then the value of orbital speed for a satellite orbiting close to its surface is __________

a) 12km/s
b) 1km/s
c) √2km/s
d) 2√2km/s

Answer: c
Explanation: Near earth's surface,
$v_0=v_e/\sqrt{2}=2/\sqrt{2}=\sqrt{2}$ km/s.

29. If gravitational constant is decreasing with time, what will remain unchanged in case of a satellite orbiting around the earth?

a) Time period
b) Orbiting radius
c) Areal velocity
d) Angular velocity

Answer: c
Explanation: The central gravitational force decreases which does not exert any torque. Hence the angular momentum and consequently areal velocity remain unchanged.

30. An elephant and an ant are to be projected out of the earth into space. What is the velocity needed to do so?

a) Elephant needs to be projected with a higher velocity
b) Ant should be projected with a higher velocity
c) Both should be projected with the same velocity
d) Elephant cannot be projected to space

Answer: c
Explanation: The escape velocity $v_e=\sqrt{2gR}$, does not depend upon the mass of the projected body. Thus we need the same velocity to project an elephant and an ant into space.

31. An astronaut, while revolving in a circular orbit happens to throw a spoon outside. What will happen to the spoon?

a) It will reach the earth surface
b) It will escape the universe
c) It will remain stationary
d) It will continue to move in a circular orbit

Answer: d
Explanation: While revolving in a circular orbit, if a spoon is thrown outside, the spoon will continue to rotate in the same circular orbit, and chase the astronaut. It will never reach the surface of the earth.

32. It is possible to place an artificial satellite in an orbit, such that it is always visible over New Delhi.

a) True
b) False

Answer: b
Explanation: A satellite remains always visible only if it revolves in the equatorial plane with a period of revolution equal to that of the earth. New Delhi does not lie in the region of the equatorial plane. Hence it is not possible to place an artificial satellite in an orbit such that it is always visible from New Delhi.

33.A satellite does not need ant fuel to circle around the earth.

a) True
b) False

Answer: a

Explanation: The gravitational force between satellite and earth provides the centripetal force required by the satellite to move in a circular orbit.

34.A satellite orbiting the earth with speed v_0. To make the satellite escape, what should be the minimum percentage increase in its velocity?

a) 41.5%
b) 44.1%
c) 41.4%
d) 40%

Answer: c

Explanation: Required percentage increase in velocity = $(v_e-v_0)/v_0 \times 100$ $(\sqrt{2}-1)\times 100=41.4\%$.

35. A person is falling from a certain height. Which of the following is likely to happen?

a) If he falls on cement floor, he gets more injuries
b) If he falls on a heap of sand, he receives less injuries
c) He gets the same injuries in both the cases
d) He is unaffected

Answer: a

Explanation: In both cases, the impulse is the same. On the cemented floor, the person is topped abruptly. So the cemented floor exerts a large force of reaction causing him severe injuries. When he falls on a heap of sand, the sand yields under his weight. This decreases the force exerted by the floor on the person.

36. Swimming is an example of which of the following?

a) Newton's first law of motion
b) Newton's second law of motion
c) Newton's third law of motion
d) Law of inertia

Answer: c

Explanation: While swimming, a man pushes water backward and in turn he is pushed forward. Thus for the backward action there is an equal and opposite forward reaction.

37. How many light years are there in one metre?

a) 9.46×10^{15}ly
b) 1.057×10^{-16}ly
c) 1ly
d) 1×10^{-16}ly

Answer: b

Explanation: 1 light year = 9.46×10^{15}m
1m = $1/(9.46\times10^{15})$ly = 1.057×10^{-16}ly.

38. An artificial satellite orbiting the earth in very thin atmosphere loses its energy gradually due to dissipation against atmospheric resistance, however small. As it comes closer and closer to earth, its speed

a) Decreases progressively
b) Remains constant
c) Becomes non-uniform
d) Increases progressively

Answer: d

Explanation: As the satellite comes closer to the earth, its potential energy decreases. As the sum of kinetic energy and potential energy remains constant, the kinetic energy and the velocity of the satellite increase. But the total energy of the satellite goes on decreasing due to the loss of energy against friction.

39. Two masses of 1g and 4g are moving with equal kinetic energy. The ratio of the magnitudes of their momenta is ____________

a) 4:1
b) √2:1
c) 1:2
d) 1:16

Answer: c
Explanation: p = √2mK
For same K, P1P2=m1m2---√=12 = 1:2.

40. The Sun's attraction of both earth and moon are external forces acting on the centre of mass of the earth-moon system.

a) True
b) False

Answer: a
Explanation: The moon moves around the earth in a circular orbit and the earth moves around the sun in an elliptical orbit. Here the mutual force of gravitation between the earth and the moon are internal forces while the Sun's attraction of both earth and moon are the external forces acting on the centre of mass of the earth-moon system.

41. On the application of a constant torque, a wheel is turned from rest through 400 radians in 10s. Find the angular acceleration.

a) 6 rad/s^2
b) 4 rad/s^2
c) 2 rad/s^2
d) 8 rad/s^2

Answer: d
Explanation: θ=400rad
ω_0=0, t = 10s, α = ?
$θ=ω_0 t+1/2\ αt^2$
$400 = 0+1/2\ α10^2$
α = 8 rad/s^2.

42. How much water a pump of 2kW can raise in one minute to a height of 10m? ($g=10m/s^2$)

a) 1000litres

b) 1200litres

c) 10litres

d) 2000litres

Answer: b

Explanation: P = W/t=mgh/t

m = Pt/gh=(2000×60)/(10×10)=1200kg.

43. A body of mass 2kg is placed on a rough horizontal plane. The coefficient of friction between body and the plane is 0.2. Then ___________

a) Body will move in forward direction if F=3N

b) Body will move in backward direction with acceleration of $0.5m/s^2$, if force F=3N

c) If F=3N, then body will be in rest condition

d) The body will move both in forward during a particular period and then remain at rest

Answer: d

Explanation: Limiting friction, f = μR = μmg = 0.2×2×9.8=3.92N

When F>3.92N the body will move in a forward direction. When F=3N, the body will move to remain at rest.

44. Which of the following can execute both translational and rotational motion under the influence of the external field?

a) Rigid body

b) Ideal body

c) Rotating body

d) A body which is stationary

Answer: a

Explanation: A rigid body is one for which the distance between different particles does not change, even though they move. Under the influence of an external force, a rigid body can execute rotational and translational motion.

45.A spring 40mm ling is stretched by the application of force. If 10N force is required to stretch the spring through 1mm, then the work done in stretching the spring through 40mm is?

a) 23J
b) 68J
c) 84J
d) 8J

Answer: d

Explanation: Spring constant, $k = F/x = 10N/1mm = 10N/(10^{-3}\ m) = 10^4\ N/m$

Work done in stretching the spring through 40m,

$W = 1/2\ kx^2 = 1/2 \times 10^4 \times (40 \times 10^{-3})^2 = 8J$.

46. Two bodies w of masses m and 4m are moving with equal kinetic energies. What is the ratio of their linear momenta?

a) 1:2
b) 1:1
c) 4:1
d) 1:4

Answer: a

Explanation: $p = \sqrt{2mE}$

For same kinetic energy, $p_1/p_2 = \sqrt{(m_1/m_2)} = \sqrt{(m/4m)} = 1:2$.

47. Water falls from a height of 60m at the rate of 15kg.s to operate a turbine. The losses due to friction forces are 10% of energy. How much power is generated by the turbine? $g=m/s^2$

a) 7kW
b) 10.2kW
c) 12.3kW
d) 8.1Kw

Answer: d

Explanation: $P = W/t = mgh/t = (15 \times 10 \times 60)/1 = 9000W = 9kW$

Loss=10%

Useful power=90% of 9kW = $(90 \times 9)/100 = 8.1kW$.

48. Force is a polar vector.
a) True
b) False

Answer: a
Explanation: Force is a polar vector because it has a point of application. It is a push or a pull that tends to change the state of rest or of uniform motion of a body.

49. A body is moving along a straight path. What will happen to the body in the absence of an external field?
a) It will stop
b) It will move with the same speed in a different path
c) It will move with the same speed along the same straight path
d) It will move with a reduced speed along the same path

Answer: c
Explanation: Galileo stated that on a horizontal plane an object should move with a constant velocity in a straight-line path. Therefore, a body moving along a straight path will continue to move in the same direction with the same speed even in the absence of external forces.

50. A person is standing in a bus. When the bus starts moving forward suddenly ____________
a) The person moves forward
b) The person remains stationary
c) The person is unaffected
d) The person moves backward

Answer: d
Explanation: A person standing in a bus moves backward when the bus moves forward. When the bus moves forward, the lower part of his body begins to move along with the bus while the upper part of his body continues to remain at rest due to inertia. That is why a person falls backward when the bus starts.

51. An object of mass 100kg is accelerated uniformly from a velocity of 4 m/s to 8 m/s in 2 seconds. Calculate the initial and final momentum of the object

a. 400 kgm/s,800 kgm./s
b. 100 kgm/s,400 kgm./s
c. 200 kgm/s,400 kgm./s
d. 400 kgm/s,400 kgm./s

ANS: 5. A

Explanation:

Initial momentum =\(mv_i =100 \times 4=400 \) kgm/s
Final Momentum = \(m_f=100 \times 8=800 \) kg/s

52. Find the magnitude of the force exerted on the object in the above question?

a. 250N
b. 50N
c.100N
d. 200 N

ANS: D

53.A boy of mass 50 Kg running at 5 m/s jumps on to a 20Kg trolley travelling in the same direction at 1.5 m/s. What is the common velocity?

a. 4m/s
b. 3 m/s
c. 3.5 m/s
d. None of the above

ANS: D

54. An object of mass 2 kg is sliding with a constant velocity of 4 m/s on a friction less horizontal table. The force required to keep the object moving with the same velocity is:

(a) 32 N

(b) 0 N

(c) 2 N

(d) 8 N

ANS: B

55. The seat belts are provided in the cars so that if the car stops suddenly due to an emergency braking, the persons sitting on the front seats are not thrown forward violently and saved from getting injured. Can you guess the law due to which a person falls in forward direction on the sudden stopping of the car?

(a) Newton's first law of motion

(b) Newton's second law of motion

(c) Newton's third law of motion

(d) Newton's law of gravitation

ANS: A

56. When a balloon held between the hands is pressed, its shape changes. This happens because:

(a) Balanced forces act on the balloon

(b) Unbalanced forces act on the balloon

(c) Frictional forces act on the balloon

(d) Gravitational force acts on the balloon

ANS: A

57. The speed of a car weighing 1500 kg increases from 36 km/h to 72 km/h uniformly. What will be the change in momentum of the car?

(a) 15000 kg km/h

(b) 15000 kg m/s

(c) 54000 kg m/s

(d) 54000 g m/s

ANS: B

58. A man wearing a bullet-proof vest stands on roller skates. The total mass is 80 kg. A bullet of mass 20 g is fired at 400 m/s. It is stopped by the vest and falls to the ground. What is then the velocity of the man?

(a) 1 m/s

(b) 0.1 m/s

(c) 0.01 m/s

(d) 0 m/s

ANS: B

59. If the unit of force and length each be increased by four times, then the unit of energy is increased by

a. 16 times
b. 8 times
c. 2 times
d. 4 times

ANS: A

60.A man pushes a wall and fails to displace it. He does

a. Negative work
b. Positive but not maximum work
c. No work at all
d. Maximum work

ANS: C

61. When a retarding force is applied to stop a train, the train stops after 80 m. If the speed is doubled, then for the same retarding force, the distance when the train stops would be

a. The same
b. Doubled
c. Halved
d. Four times

ANS: D

62. You lift a heavy book from the floor of the room and keep it in the bookshelf having a height of 2 m. This process takes 5 seconds. The work done by you will depend on

a. Mass of the book and the time taken
b. Weight of the book and height of the bookshelf
c. Height of the bookshelf and the time taken
d. Mass of the book, height of the bookshelf and the time taken

ANS: B

63.A body of mass m kg is lifted by a man to a height of one metre in 30 seconds. Another man lifts the same mass to the same height in 60 seconds. The work done by them are in the ratio

a. 1:2
b. 1:1
c. 2:1
d. 4:1

ANS: B

64.A force of 5 N, making an angle θ with the horizontal, acting on an object displaces it by 0.4 m along the horizontal direction. If the object gains kinetic energy of 1 J, the horizontal component of the force is

a. 1.5 N
b. 2.5 N
c. 3.5 N
d. 4.5 N

ANS: B

65. The work done against gravity in taking 10 kg mass at 1 m height in 1 sec will be

a. 49 J
b. 98 J
c. 196 J
d. None of these

ANS: B

66.A body of mass 6 kg is under a force which causes displacement in it is given by $S = t^2/4$ mts where t is time. The work done by the force in 2 seconds is

a. 12 J
b. 9 J
c. 6 J
d. 3 J

ANS: D

67.A spring with an initial stretch of 0.20 m has a force constant 10 N/m. When the stretch is changed to 0.25 m, the increase in potential energy is

a. 0.2 joule
b. 0.3 joule
c. 0.1 joule
d. 0.5 joule

ANS: C

68. Same force is used to stretch two springs of spring constants 1500 N/m and 3000 N/m respectively. What will be the ratio of potential energy?

a. 1:4
b. 2:1
c. 4:1
d. 1:2

ANS: B

69.A body moving with a velocity 10 m/s and having a mass 0.1 kg hits a spring (fixed at the other end) of force constant 1000 N/m and comes to rest after compressing the spring. What will be the value of compression of the spring?

a. 0.1 m
b. 0.2 m
c. 0.01 m
d. 0.5 m

ANS: B

70. What would be the maximum compression of the spring if a mass of 0.5 kg moving on a horizontal smooth surface with a speed of 1.5 m/s collides with a nearly weightless spring of force constant k= 5 N/m.

a. 0.5 m
b. 0.12 m
c. 1.5 m
d. 0.15 m

ANS: C

71. A spring has a spring constant k. When the spring is stretched through 1 cm, the potential energy will be U. What will be the potential energy if it is stretched by 4 cm?

a. 4 U
b. 8 U
c. 16 U
d. 2 U

ANS: C

72. The degree of freedom for a free particle in space are __________

(a) one
(b) two
(c) three
(d) zero

ANS: C

73. ____________ constraints are independent of time.

(a) Holonomic
(b) Non-Holonomic
(c) Scleronomous
(d) Rheonomous

ANS: C

74.____________ constraints are time dependent.

(a) Holonomic
(b) Non-Holonomic
(c) Scleronomous
(d) Rheonomous

ANS: D

75. The Lagrangian equations of motion are ____________ order differential equations.

(a) first
(b) second
(c) zero
(d) forth

ANS: B

76. The lagrangian for a charged particle in an electromagnetic field is Where T is kinetic energy and φ and A are magnetic scalar and vector potentials

(a) L= T+ q φ + q(v.A)
(b) L= T – qφ – q(v.A)
(c) L= T – qφ + q(v.A)
(d) L= T + qφ – q(v.A)

ANS: C

77. The Lagrangian of a system is

$$L = \frac{13}{2}m\dot{x}^2 + 4m\dot{x}\dot{y} + 3m\dot{y}^2 - mg(x + 2y)$$

Which one of the following is conserved?

A) 11x + y
B) 11x – y
C) x + 11y
D) x – 11y

Ans: A

Solution:

$$L = \frac{13}{2}m\dot{x}^2 - 4m\dot{x}\dot{y} - 3m\dot{y}^2 - mg(x - 2y)$$

$$\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{x}}\right) - \frac{\partial L}{\partial x} = 0$$

$$\Rightarrow \qquad \frac{d}{dt}(13m\dot{x} + 4m\dot{y}) - (-mg) = 0$$

$$\Rightarrow \qquad 13m\ddot{x} + 4m\ddot{y} + mg = 0 \qquad \ldots(1)$$

$$\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{y}}\right) - \frac{\partial L}{\partial y} = 0$$

$$\Rightarrow \qquad \frac{d}{dt}(4m\dot{x} - 6m\dot{y}) - (-2mg) = 0$$

$$\Rightarrow \qquad 4m\ddot{x} - 6m\ddot{y} + 2mg = 0 \qquad \ldots(2)$$

$(i) - \frac{1}{2}(ii)$.

$$11m\ddot{x} + m\ddot{y} = 0 \Rightarrow \frac{d}{dt}(11m\dot{x} + m\dot{y}) = 0$$

Or. $11\dot{x} - \dot{y}$ is conserved

78. If the Hamiltonian of a system with two degrees of freedom is given by

$$H = \frac{(p_x - y)^2 + (p_y - x)^2}{2m}$$

then the quantity that is conserved is

A) Only H
B) H, Px, Py
C) H, L_z
D) H, px, py, Lz

ANS: C

Solution:

$$H = \frac{1}{2m}\left[(p_x - y)^2 - (p_y + x)^2\right]$$

$$L = \sum_i p_i \dot{q}_i - H$$

$$\dot{x} = \frac{\partial H}{\partial p_x} = \frac{1}{2m}\left[2(p_x - y)\right] \Rightarrow \quad p_x = m\dot{x} + y$$

$$\dot{y} = \frac{\partial H}{\partial p_y} = \frac{1}{2m}\left[2(p_y - x)\right] \Rightarrow \quad p_y = m\dot{y} - x$$

$$L = p_x \dot{x} - p_y \dot{y} - \frac{1}{2m}\left[(p_x - y)^2 + (p_y - x)^2\right]$$

$$= \frac{p_x}{m}(p_x - y) + \frac{p_y}{m}(p_y - x) - \frac{1}{2m}\left[p_x^2 + y^2 - 2p_x y + p_y^2 + x^2 + 2p_y x\right]$$

$$= \frac{p_x^2}{2m} - \frac{p_y^2}{2m} - \frac{x^2}{2m} - \frac{y^2}{2m} = \frac{(m\dot{x} - y)^2}{2m} + \frac{(m\dot{y} - x)^2}{2m} - \frac{x^2}{2m} - \frac{y^2}{2m}$$

$$L = \frac{1}{2m}(\dot{x}^2 - \dot{y}^2) + \dot{x}y - \dot{y}x$$

L is not an explicit function of time.

So. H is a conserved quantity

x, y are not cyclic coordinates. therefore. corresponding generalised momentum p_x and p_y. respectively are not conserved.

L is invariant under rotation about z-axis.

So. L_z is a conserved quantity.

Therefore. H. L_z are conserved quantity.

79. A train has a rest length of 100 m. Traveling at a very high velocity, it goes through a tunnel of length 80 m. Observers located at both ends of the tunnel note that at one instant the train appears to exactly fit within the tunnel. What is the velocity of the train expressed in units of c?

a) 0.866c
b) 0.333c
c) 0.50c
d) 0.60c

ANS: C

80. The decay of a sample of radioactive atoms is studied by observers moving in different ways. One moves at 0.8c, another at 0.5c, another at 0.25c, and one at speed zero with respect to the sample. The one with a speed of __________ will measure the shortest half-life.

a) 0.8c
b) Zero
c) 0.5c
d) 0,25c
ANS: B

81. A satellite moving around the earth constitutes________________?

a. An inertial frame of reference
b. Non-inertial frame
c. Neither inertial nor non-inertial
d. Both inertial and non-inertial

ANS: B

82. When a bus suddenly take a turn, the passengers are thrown outwards because of:

(a) Speed of motion

(b) Inertia of motion

(c) Acceleration of motion

(d) None of these.

ANS: B

83. An accelerated frame of reference is

(a) Inertial frame of reference

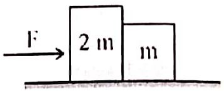
(b) Static frame of reference

(c) Non-inertial frame of reference

(d) None of these.

ANS: C

84. Two blocks are in contact on a frictionless table. One has mass m and the other 2m. A force F is applied on 2 m as shown in figure. Now the same force F is applied from the right on m. In the two cases the ratio of force of contact between the two blocks will is:



(a) Same

(b) 1 : 2

(c) 2 : 1

(d) 1 : 3

ANS: B

ELECTROMAGNETISM

[Electrostatics, Magneto Statics, AC and DC Circuits, Electromagnetic Induction, Maxwell's Equations and Electromagnetic Waves]

1. The coulomb's force between the 2 point charges 10μC and 5μC placed at a distance of 150cm is

A. 0.2 N
B. 0.5 N
C. 2 N
D. 10 N

ANS: A

2. If 5 J of work is required to shift 10 C charge from one place to another then the potential difference is

A. 0.5 V
B. 2 V
C. 5 V
D. 10 V

ANS: A

3. The force between two charges is 120 N. If the distance between the charges is doubled, the force will be
(a) 60 N
(b) 30 N
(c) 40 N
(d) 15 N
Ans: b

4. The electric field intensity at a point situated 4 meters from a point charge is 200 N/C. If the distance is reduced to 2 meters, the field intensity will be
(a) 400 N/C
(b) 600 N/C
(c) 800 N/C
(d) 1200 N/C
Ans: c

5. A field line and an equipotential surface are

(a) always parallel

(b) always at 90°

(c) inclined at any angle 0

(d) none of the above

Ans: b

6. If the sheet of a bakelite is inserted between the plates of an air capacitor, the capacitance will

(a) decrease

(b) increase

(c) remains unchanged

(d) become zero

Ans: b

7. A capacitor stores 0.24 coulombs at 10 volts. Its capacitance is

(a) 0.024 F

(b) 0.12 F

(c) 0.6 F

(d) 0.8 F

Ans: a

8. If three 15 uF capacitors are connected in series, tne net capacitance is

(a) 5 uF

(6) 30 uF

(c) 45 uF

(d) 50 uF

Ans: a

9. Two plates of a parallel plate capacitor after being charged from a constant voltage source are separated apart by means of insulated handles, then the

(a) Voltage across the plates increases

(b) voltage across the plates decreases

(c) charge on the capacitor decreases

(d) charge on the capacitor increases

Ans: b

10. Voltage applied across a ceramic dielectric produces an electrolytic field 100 times greater than air. What will be the value of dielectric constant ?

(a) 50
(6) 100
(c) 150
(d) 200
Ans: b

11. The value of dielectric constant for vacuum is taken as

(a) zero
(b) 1
(c) 4
(d) 10
Ans: b

12. Paper capacitors usually have a tolerance of

(a) ± 5%
(b) ± 10%
(c) ± 15%
(d) ± 20%
Ans: b

13. The electrostatic force between two charges of one coulomb each and placed at a distance of 0.5 m will be

(a) 36 x 10fa
(b) 36 x 107 N
(c) 36 x 108 N
(d) 36 x 109 N
Ans: d

14. The dielectric constant (relative permittivity) of glass is given by

(a) 0.1 to 0.4
(b) 0.5 to 1.0
(c) 2.0 to 4.0
(d) 5 to 100
Ans: d

15. A capacitance of 100 fiF is connected in series with a resistance of 8000 £2. The time constant of the circuit is
(a) 0.2 s
(b) 0.4 s
(c) 0.6 s
(d) 0.8 s
Ans: d

16. The time constant of an R-C circuit is defined as the time during which capacitor charging voltage actually rises to ______ percent of its value.
(a) 37, initial
(b) 62, initial
(c) 62, final
(d) 37, final
Ans: c

17. Which of the following capacitor is preferred in case of single phase motor ?
(a) Mica capacitor
(b) Paper capacitor
(c) Electrolytic capacitor
(d) Ceramic capacitor
Ans: c

18. A condenser suitable for D.C. only is
(a) metallic plate variable gang condenser
(b) metallic paper capacitor
(c) oil impregrated paper condenser
(d) poled aluminium electrolytic condenser
Ans: d

19. An uncharged conductor is placed near a charged conductor, then
(a) the uncharged conductor gets charged by conduction
(6) the uncharged conductor gets charged by induction and then attracted towards the charging body
(c) the uncharged conductor is attracted first and then charged by induction
(d) it remains as such
Ans: b

20. Permittivity is expressed in
(a) Farad/sq-m
(b) Farad/meter
(c) Weber/meter
(d) Weber/sq-m
Ans: b

21. Materials subjected to rapid reversal of magnetism should have
(a) large area oiB-H loop
(b) high permeability and low hysteresis loss
(c) high co-ercivity and high retentivity
(d) high co-ercivity and low density
Ans: b

22. Indicate which of the following material does not retain magnetism permanently.
(a) Soft iron
(b) Stainless steel
(e) Hardened steel
(d) None of the above
Ans: a

23. The main constituent of permalloy is
(a) cobalt
(b) chromium
(c) nickel
(d) tungsten
Ans: c

24. Two infinitely long parallel conductors in vacuum any separated 1 metre between centers >then a current of 1 ampere flows the. uk each conductor, produce on each other a force of
(a) 2 x 1(T2 N/m)
(b) 2 x KT3 N/m
(c) 2 x 10"5 N/m
(d) 2x 1(T7 N/m)
Ans: d

25. In the left hand rule, forefinger always represents
(a) voltage
(b) current
(c) magnetic field
(d) direction of force on the conductor
Ans: c

26. Ferrites are a sub-group of
(a) non-magnetic materials
(6) ferro-magnetic materials
(c) paramagnetic materials
(d) ferri-magnetic materials
Ans: d

27. One maxwell is equal to
(a) 10 webers
(b) 10 webers
(c) 10 webers
(d) 10 webers
Ans: d

28. Two long parallel conductors carry 100 A. If the conductors are separated by 20 mm, the force per meter of length of each conductor will be
(a) 100 N
(b) 10 N
(c) 1 N
(d) 0.1 N
Ans: d

29. A 300 mm long conductor is carrying a current of 10 A and is situated at right angles to a magnetic field having a flux density of 0.8 T ; the force on the conductor will be
(a) 240 N
(6) 24 N
(c) 2.4 N
(d) 0.24 N
Ans: c

30. A 200 turn coil having an axial length of 30 mm and a radius of 10 mm is pivoted in a magnetic field having a flux density of 0.8 T. If the coil carries a current of 0.5 A, the torque acting on the coil will be

(a) 8 N-m

(b) 0.48 N-m

(e) 0.048 N-m

(d) 0.0048 N-m

[Hint. Torque = 2BIlNr N-m]

Ans: c

31. The electromagnet has 50 turns and a current of 1A flows through the coil. If the length of the magnet circuit is 200 mm, what is the magnetic field strength?

(a) 2500 AT/m

(b) 250 AT/m

(c) 25 AT/m

(d) 2.5 AT/m

Ans: b

32. A square cross-sectional magnet has a pole strength of 1 x 10 Wb and cross-sectional area of 20 mm x 20 mm. What is the strength at a distance of 100 mm from the unit pole in air?

(a) 63.38 N/Wb

(b) 633.8 N/Wb

(c) 6338 N/Wb

(d) 63380 N/Wb

Ans: c

33. The Biot-savart's law is a general modification of

(a) Kirchhoffs law

(b) Lenz's law

(c) Ampere's law

(d) Faraday's laws

Ans: c

34. Hysteresis loop in case of magnetically hard materials is more in shape as compared to magnetically soft materials.
(a) circular
(b) triangular
(c) rectangular
(d) none of the above
Ans: c

35. A rectangular magnet of magnetic moment M is cut into two pieces of same length, the magnetic moment of each piece will be
(a) M
(6) M/2
(c) 2 M
(d) M/4
Ans: b

36. What will be the current passing through the ring shaped air cored coil when number of turns is 800 and ampere turns are 3200?
(a) 2
(b) 4
(c) 6
(d) 8
Ans: b

37. A certain amount of current flows through a ring-shaped coil with fixed number of turns. How does the magnetic induction B varies inside the coil if an iron core is threaded into coil without dimensional change of coil?
(a) Decreases
(b) Increases
(c) Remains same
Ans: b

38. The susceptibility of paramagnetic materials generally lies between
(a) KT3 and 1CT6
(b) 1CT3 and 1CT7
(c) KT4 and KT8
(d) 10"2 and KT5
Ans: a

39. Core of an electromagnet should have

(a) low coercivity
(6) high susceptibility
(c) both of the above
(d) none of the above

Ans: c

40. Temporary magnets are used in

(a) loud speakers
(b) generators
(c) motors
(d) all of the above

Ans: d

41.A 110 V d.c. heater is used on an a.c. source, such that the heat produced is same as it produces when connected to 110 V dc in same time-intervals. What would be the r.m.s. value of the alternating voltage?

a) 110 V

b) 220 V

c) 330 V

d) 440 V

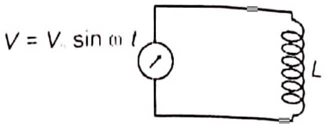
ANS: a

42. The time required for a 50 Hz sinusoidal alternating current to change its value from zero to the r.m.s. value

a) 2.5×10^{-3} s
b) 10^{-1} s
c) 10^{-6} s
d) 1.5×10^{-2} s

ANS: a

43. There is no resistance in the inductive circuit. Kirchhoff 's voltage law for the circuit is



e. a)

$$V = L\frac{di}{dt}$$

f. b)

$$V - L\frac{di}{dt} = 0$$

g. c)

$$V - L^2\frac{di}{dt} = 0$$

h. d) None of these

Answer:

$$V = L\frac{di}{dt}$$

44. An inductive circuit contains a resistance of 10 ohms and an inductance of 2 henry. If an alternating voltage of 120 V and frequency 60 Hz is applied to this circuit, the current in the circuit would be nearly

a) 0.16 A

b) 0.48 A

c) 0.80 A

d) 0.32 A

ANS: A

45. A coil and a bulb are connected in series with a 12 volt direct current source. A soft iron core is now inserted in the coil. Then

a) The intensity of the bulb remains the same

b) The intensity of the bulb increases

c) The intensity of the bulb decreases

d) Nothing can be said

ANS: A

46. When 100 volt d.c. is applied across a solenoid, a current of 1.0 A flows in it. When 100 volt a.c. is applied across the same coil, the current drops to 0.5 A. If the frequency of a.c. source is 50 Hz the impedance and inductance of the solenoid is

a) 200 ohm and 0.55 henry

b) 100 ohm and 0.86 henry

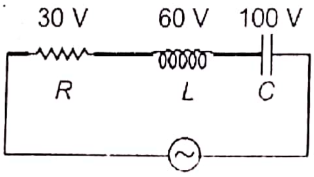
c) 200 ohm and 1.0 henry

d) 100 ohm and 0.93 henry

ANS: A

47.

In a series RLC circuit, potential differences across R, L and C are 30 V, 60 V and 100 V respectively as shown figure. The e.m.f. of source (in volts) is



a) 50

b) 40

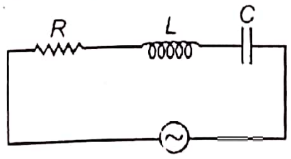
c) 70

d) 190

ANS: A

48.

In the following circuit the emf of source is E_0 = 200 volt, R = 20 Ω, L = 0.1 henry, C = 10.6 farad and frequency is variable then the current at frequency f = 0 and f = ∞ is



a) Zero, zero

b) 10 A, 10 A

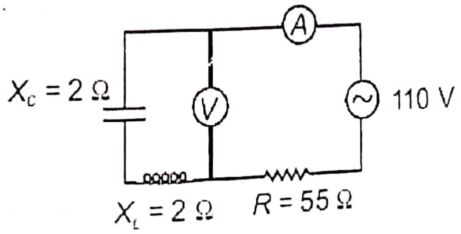
c) 10 A, zero

d) Zero, 10 A

ANS: A

49.

The reading of ammeter in the circuit is


A
$X_C = 2\ \Omega$
V
110 V
$X_L = 2\ \Omega$
$R = 55\ \Omega$

a) 2 A b) 3 A

c) Zero d) 1 A

ANS: A

50. The virtual current of 4 A and 50 Hz flows in an AC circuit containing a coil. The power consumed in the coil is 240 W. If the virtual voltage across the coil is 100 V, then its resistance will be

a)

15 Ω

b)

$\frac{1}{\pi}$ Ω

c)

$\frac{1}{5\pi}$ Ω

d) NONE OF THESE

ANS: A

51. A step-up transformer operates on 220 V line and supplies 2.2 A. The ratio of primary and secondary winding is 11 : 50. The output voltage in the secondary is

a) 1000 V

b) 0 V

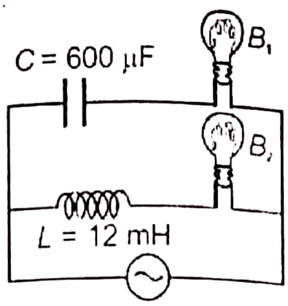
c) 100 V

d) 220 V

ANS: A

52.

In the circuit shown in figure, if both the bulbs B_1 and B_2 are identical then



a)

As the frequency is increased, brightness of B_1 will increase and that of B_2 will decrease

b)

As the frequency is decreased, the brightness of B_1 will increase and that of B_2 will decrease

c)

B_2 will be brighter than B_1

d)Both bulbs have equal brightness

ANS: A

53. With increase in frequency of an a.c. supply, the impedance of an LCR series circuit

a) Decreases at first, becomes minimum and then increases

b) Increases

c) Decreases

d) Remains constant

ANS: A

54.

A sinusoidal supply of frequency 10 Hz and r.m.s. voltage 12 V is connected to a 2.1 μF capacitor. What is r.m.s. value of current?

a) 1.6 mA

b) 26 mA

c) 20 mA

d) 5.5 mA

ANS: A

55. In an AC circuit a low value of KVAR compared with KW indicates

A. Low efficiency
B. High power factor
C. Unity power factor
D. Maximum load current
Ans: B

56. A metal conductor of length 1 m rotates vertically about one of its ends at angular velocity 5 rad s^{-1}. If the horizontal component of earth's magnetism is 2×10^{-5} T, then e.m.f. developed between the two ends of the conductor is:
(a) 5 μV
(b) 50 μV
(c) 5 mV
(d) 50 mV

ANS: A

57. Coil of L = 8.4 mH and R = 6 Ω is connected to a 12 V battery. The current in the coil is 1.0 A at approx'time of:
(a) 500 s
(b) 20 s
(c) 35 ms
(d) 1 ms

ANS: D

58. A choke is used as a resistance in :

(a) dc circuits
(b) ac circuits
(c) both ac and dc circuits
(d) neither (a) nor (b)

Ans: B

59. The energy stored in a 50 mH inductor carrying a current of 4 A is:

(a) 0.1 J
(b) 0.4 J
(c) 0.04 J
(d) 0.01 J

ANS: B

60. The flux linked with a coif at any instant t is given by Ø = $10t^2 - 50t + 250$. The induced emf at t = 35 is:

(a) 10 V
(b) 190 V
(c) -190 V
(d) -10 V

ANS: D

61. Two coils of self inductance 2 mil and 8 mil are placed so close together that the effective flux in one coil is completely linked with other. The mutual inductance between these coils is :

(a) 4 mH
(b) 16 mH
(c) 10 mH
(d) 6 mH

ANS: C

62. Two coils have inductances of 8 mH and 18 mH and a co-efficient of coupling of 0.5. If the two coils are connected in series aiding, the total inductance will be

(a) 32 mH

(b) 38 mH

(c) 40 mH

(d) 48 mH

Ans: b

63. A 200 turn coil has an inductance of 12 mH. If the number of turns is increased to 400 turns, all other quantities (area, length etc.) remaining the same, the inductance will be

(a) 6 mH

(b) 14 mH

(c) 24 mH

(d) 48 mH

Ans: d

64. Two coils have self-inductances of 10 H and 2 H, the mutual inductance being zero. If the two coils are connected in series, the total inductance will be

(a) 6 H

(b) 8 H

(c) 12 H

(d) 24 H

Ans: c

65. In case all the flux from the current in coil 1 links with coil 2, the co-efficient of coupling will be

(a) 2.0

(b) 1.0

(c) 0.5

(d) zero

Ans: b

66. A coil with negligible resistance has 50V across it with 10 mA. The inductive reactance is

(a) 50 ohms	(b) 500 ohms
(c) 1000 ohms	(d) 5000 ohms

Ans: d

67. A conductor carries 125 amperes of current under 60° to a magnetic field of 1.1 tesla. The force on the conductor will be nearly

(a) 50 N
(b) 120 N
(c) 240 N
(d) 480 N

Ans: b

68. Find the force acting on a conductor 3m long carrying a current of 50 amperes at right angles to a magnetic field having a flux density of 0.67 tesla.

(a) 100 N
(b) 400 N
(c) 600 N
(d) 1000 N

Ans: a

69. An average voltage of 10 V is induced in a 250 turns solenoid as a result of a change in flux which occurs in 0.5 second. The total flux change is

(a) 20 Wb
(b) 2 Wb
(c) 0.2 Wb
(d) 0.02 Wb

Ans: d

70. A 500 turns solenoid develops an average induced voltage of 60 V. Over what time interval must a flux change of 0.06 Wb occur to produce such a voltage ?

(a) 0.01 s
(b) 0.1 s
(c) 0.5 s
(d) 5 s

Ans: c

71. A coil induces 350 mV when the current changes at the rate of 1 A/s. The value of inductance is

(a) 3500 mH
(b) 350 mH
(c) 250 mH
(d) 150 mH

Ans: b

72. Two 300 uH coils in series without mutual coupling have a total inductance of

(a) 300 uH

(b) 600 uH

(c) 150 uH

(d) 75 uH

Ans: b

73. Which circuit element(s) will oppose the change in circuit current ?

(a) Resistance only

(b) Inductance only

(c) Capacitance only

(d) Inductance and capacitance

Ans: b

74. A coil is wound on iron core which carries current I. The self-induced voltage in the coil is not affected by

(a) variation in coil current

(b) variation in voltage to the coil

(c) change of number of turns of coil

(d) the resistance of magnetic path

Ans: b

75. The polarity of the induced voltage can be determined by using the left-hand generator rule.

(a) Yes

(b) No

Ans: a

76. Increasing the field or increasing the current will decrease the force on the conductor.

(a) Yes

(b) No

Ans: b

77. When a conductor moves in the field, so that it makes an angle 8 with the lines of flux, the force F is given as : F -= Bl sin2 0.

(a) Yes

(b) No **(Ans: b)**

78. The self-inductance of the coil may be defined as equal to the e.m.f. induced in volts when the current in the circuit changes at the rate of unit Weber turns.

(a) Yes
(b) No

Ans: b

79. Which of the following is the expression for Lorentz force?

a) qE
b) q (v X B)
c) ma + qE
d) qE + q (v X B)

ANS: D

80. In vacuum or free space, what observations are made?

a) $\rho = \rho_o$, $J = 0$
b) $\rho = 0$, $J = J_o$
c) $\rho = 0$, $J = 0$
d) $\rho = \rho_o$, $J = J_o$

ANS: C

81. A point charge of 10×10^{-6} C is at the centre of a cubical Gaussian surface of sides 0.5 m. What is the flux for the surface?

a) 1.12×10^5 Nm^2/C
b) 2.45×10^5 Nm^2/C
c) 3.12×10^5 Nm^2/C
d) 3.45×10^5 Nm^2/C

Ans: A

82. If the velocity of a charged particle in perpendicular electric and magnetic field is 7.27×10^6m/s and the Electric field is 6×10^6 N/c, what should be the value of magnetic field for velocity sector?

a) 0.45 T
b) 0.78 T
c) 0.83 T
d) 0.94 T

ANS: c

Explanation: As we know, for velocity selector, v = E/B
Therefore, B = E/v
= 6 X 10^6/7.27 X 10^6
= 0.83 T.

83. Find the charge density when the electric flux density is given by 2x i + 3y j + 4z k.

a) 10
b) 9
c) 24
d) 0

Answer: b

Explanation: The charge density is the divergence of the electric flux density by Maxwell's equation. Thus ρ = Div (D) and Div (D) = 2 + 3 + 4 = 9. We get ρ = 9 units.

84. The Faraday's law states about which type of EMF?

a) Transformer EMF
b) Back EMF
c) Generator EMF
d) Secondary EMF

Answer: a

Explanation: The stationary loop in a varying magnetic field results in an induced emf due to the change in the flux linkage of the loop. This emf is called as induced or transformer EMF.

85. In which of the following forms can Maxwell's equation not be represented?

a) Static
b) Differential
c) Integral
d) Harmonic

Answer: a

Explanation: Maxwell equations can be represented in differential/point form and integral form alternatively. Sometimes, it can be represented by time varying fields called harmonic form.

86. The charge build up in the capacitor is due to which quantity?

a) Conduction current
b) Displacement current
c) Convection current
d) Direct current

Answer: b

Explanation: The charge in the capacitor is due to displacement current. It is the current in the presence of the dielectric placed between two parallel metal plates.

87. Find the flux enclosed by a material of flux density 12 units in an area of 80cm.

a) 9.6
b) 12/80
c) 80/12
d) 12/0.8

Answer: a

Explanation: The total flux in a material is the product of the flux density and the area. It is given by flux = 12 x 0.8= 9.6 units.

88. Find the electric flux density of a material with charge density 16 units in unit volume.

a) 1/16
b) 16t
c) 16
d) 162

Answer: c

Explanation: The electric flux density from Maxwell's equation is given by $D = \int \rho \, dv$. On substituting $\rho = 16$ and $\int dv = 1$, we get $D = 16$ units.

89. Find the electric field applied on a system with electrons having a velocity 5m/s subjected to a magnetic flux of 3.6 units.

A. 15
B. 18
C. 1.38
D. 0.72

Answer: B

Explanation: The electric field intensity is the product of the velocity and the magnetic flux density. Thus E = v x B, on substituting v = 5 and B = 3.6, we get E = 5 x 3.6 = 18 units.

90. Calculate the emf of a material having a flux linkage of $2t^2$ at time t = 1second.

A. 2
B. 4
C. 8
D. 16

Answer: B

Explanations: The emf of a material is given by Vemf = -dλ/dt. On substituting λ = $2t^2$, the emf is 4t. At t = 1 sec, the emf will be 4 units.

91. Calculate the emf of a material having flux density 5sin t in an area of 0.5 units.

A. 2.5 sin t
B. -2.5 cos t
C. -5 sin t
D. 5 cos t

Answer: D

Explanation: The emf can be written as Vemf = -d(∫B.ds)/dt. It can be written as Vemf = -B= -5sin t, since the integration and differentiation gets cancelled.

92. Find the time constant of a capacitor with capacitance of 2 microfarad having an internal resistance of 4 megaohm.

A. 2
B. 0.5
C. 8
D. 0.25

Answer: C

Explanation: The time constant of capacitor is given by T = RC, where R = 4×10^6 and C = 2×10^{-6}. Thus T = 4×10^6 x2x10^{-6} = 8 seconds.

93. Find the electric field applied on a system with electrons having a velocity 5m/s subjected to a magnetic flux of 3.6 units.

A. 15
B. 18
C. 1.38
D. 0.72

Answer: B
Explanation: The electric field intensity is the product of the velocity and the magnetic flux density. Thus E = v x B, on substituting v = 5 and B = 3.6, we get E = 5 x 3.6 = 18 units.

94. To find D from B, sequence followed will be

A. B-E-D
B. B-H-D
C. E-H-D
D. E-B-D

Answer: A
Explanation: Using Maxwell equation, from B we can calculate E by Curl(E) = -dB /dt. From E, D can be calculated by D = εE. Thus the sequence is B->E->D.

95. Maxwell second equation is based on which law?

A. Ampere law
B. Faraday law
C. Lenz law
D. Coulomb law

Answer: A
Explanation: The second Maxwell equation is based on Ampere law. It states that the field intensity of a system is same as the current enclosed by it, i.e, Curl(H) = J.

96. The Maxwell second equation that is valid in any conductor is

A. Curl(H) = Jc
B. Curl(E) = Jc
C. Curl(E) = Jd
D. Curl(H) = Jd

Answer: A

Explanation: For conductors, the conductivity parameter σ is significant and only the conduction current density exists. Thus the component J = Jc and Curl(H) = Jc.

97. Find the displacement current density of a material with flux density of 5sin t

A. 2.5cos t
B. 2.5sin t
C. 5cos t
D. 5sin t

Answer: C

Explanation: The displacement current density is the derivative of the flux density. Thus Jd = dD/dt. Put D = 5sin t in the equation, we get Jd = 5cos t units.

98. Find the conduction current density of a material with conductivity 200units and electric field 1.5 units.

A. 150
B. 30
C. 400/3
D. 300

Answer: D

Explanation: The conduction current density is given by Jc = σE, where σ = 200 and E = 1.5. Thus we get, Jc = 200 x 1.5 = 300 units.

99. Calculate the conduction density of a material with resistivity of 0.02 units and electric intensity of 12 units.

A. 300
B. 600
C. 50
D. 120

Answer: B

Explanation: The conduction density is given by Jc = σE, where σ is the inverse of resistivity and it is 1/0.02 = 50. Thus we get, Jc = 50 x 12 = 600 units.

100. The total current density is given as 0.5i + j – 1.5k units. Find the curl of the magnetic field intensity.

A. 0.5i – 0.5j + 0.5k

B. 0.5i + j -1.5k

C. i – j + k

D. i + j – k

Answer: B

Explanation: By Maxwell second equation, the curl of H is same as the sum of conduction current density and displacement current density. Thus Curl(H) = J = 0.5i + j – 1.5k units.

101. Both the conduction and displacement current densities coexist in which medium?

A. Only conductors in air

B. Only dielectrics in air

C. Conductors placed in any dielectric medium

D. Both the densities can never coexist

Answer: C

Explanation: Conduction density exists only for good conductors and displacement density is for dielectrics in any medium at high frequency. Thus both coexist when a conductor is placed in a dielectric medium.

102. Which equation will hold good for a magnetic material?

A. Line integral of H is zero

B. Surface integral of H is zero

C. Line integral of B is zero

D. Surface integral of B is zero

Answer: D

Explanation: We know that the divergence of B is zero. From Stokes theorem, the surface integral of B is equal to the volume integral of divergence of B. Thus surface integral of B is also zero.

103. The dipole formation in a magnet is due to

A. Interaction between the north and south poles together

B. Interaction between the north pole with the air

C. Interaction between the south pole with the air

D. Interaction of north and south pole separately with air

Answer: A

Explanation: In any magnetic material or magnet, the dipoles exist. This is due to the magnetic lines of force joining the north to south poles. The interaction between these two poles together leads to dipole formation.

104. Find the electric flux density of a material whose charge density is given by 12 units in a volume region of 0.5 units.

A. 12

B. 24

C. 6

D. 48

Answer: C

Explanation: By Gauss law, Div(D.= ρv. To get D, integrate the charge density given. Thus D = ∫ρv dv, where ρv = 12 and ∫dv = 0.5. We get, D = 12 x 0.5 = 6 units.

105. The sequence for finding E when charge density is given is

A. E-D-ρv

B. E-B-ρv

C. E-H-ρv

D. E-V-ρv

Answer: A

Explanation: From the given charge density ρv, we can compute the electric flux density by Gauss law. Since, D = εE, the electric field intensity can also be computed. Thus the sequence is E-D-ρv.

106. The Maxwell equation ∇×E=(frac{-partial B}{partial t}) is derived from which law?

a) Amperes law

b) Faradays Law

c) Lens law

d) Gauss law

Answer: b

107. The minus sign in the Faradays law of induction is given by ______

a) Lens Law
b) Gauss law
c) Amperes Law
d) Gauss law

Answer: a

Explanation: Lens law gives only the reason for the negative sign in the Faradays law of induction
emf=(-frac{partial phi}{partial t})
The minus sign indicates the direction of induced current.

108. Electromagnetic waves travelling in a medium having relative permeability $\mu_r = 1.3$ and relative permittivity $E_r = 2.14$. The speed of electromagnetic waves in medium must be

(a) 1.8×10^8 ms^{-1}
(b) 1.8×10^4ms^1
(c) 1.8×10^6ms^1
(d) 1.8×10^2 ms^{-1}

Answer: a

Explanation: (a) speed of emw

$$v = \frac{c}{\sqrt{\mu_r \varepsilon_r}} = \frac{3 \times 10^8}{\sqrt{2.14 \times 1.3}}$$

$$= 1.8 \times 10^8 \text{ms}^{-1}$$

109. In electromagnetic wave if ue and um are mean electric and magnetic energy densities respectively, then

(a) $u_e = u_m$ (b) $u_e > u_m$
(c) $u_e < u_m$ (d) $u_e^2 = \frac{1}{2} u_m^2$

Answer: a

Explanation: (a) Energy is equally distributed among electric field and magnetic field

110. The correct option, if speeds of gamma rays, X-rays and microwave are V_g, V_x and V_m respectively will be.

(a) $V_g > V_x > V_m$

(b) $V_g < V_x < V_m$

(c) $V_g > V_x > V_m$

(d) $V_g = V_x = V_m$

Answer: d

Explanation: (d) All electromagnetic waves travel with the speed of light in space.

111. Maxwell in his famous equations of electromagnetism introduced the concept of

(a) ac current

(b) displacement current

(c) impedance

(d) reactance

ANS: B

112. The conduction current is same as displacement current when source is

(a) ac only

(b) dc only

(c) either ac or dc

(d) neither dc nor ac

ANS: C

113. If a variable frequency ac source is connected to a capacitor then with decrease in frequency the displacement current will

(a) increase

(b) decrease

(c) remains constant

(d) first decrease then increase

ANS: B

114. An electromagnetic wave can be produced, when charge is

(a) moving with a constant velocity

(b) moving in a circular orbit

(c) falling in an electric field

(d) both (b) and (c)

ANS: D

115. Which of the following has/have zero average value in a plane electromagnetic wave?
(a) Both magnetic and electric fields
(b) Electric field only
(c) Magnetic field only
(d) None of these

ANS: A

116. A charged particle oscillates about its mean equilibrium position with a frequency of 109 Hz. The frequency of electromagnetic waves produced by the oscillator is
(a) 10^6 Hz
(b) 10^7 Hz
(c) 10^8 Hz
(d) 10^9 Hz

ANS: D

117. A plane electromagnetic wave propagating along x direction can have the following pairs of Eand B
(a) E_x, B_y.
(b) E_y, B_z.
(c) B_x, E_y.
(d) None of these

ANS: B

118. A charged particle oscillates about its mean equilibrium position with a frequency of 10^9 Hz. For producing electromagnetic waves which one is not true?
(a) They will have frequency of 10^9 Hz.
(b) They will have frequency of 2×10^9 Hz.
(c) They will have a wavelength of 0.3 m.
(d) They fall in the region of radio waves.

ANS: B

WAVES AND OPTICS

[Wave Properties, Superposition, Interference, Diffraction, Geometrical Optics Polarization, Doppler Effect]

1. When a pebble is dropped into a pond of still water, what happens?
   a) Particles move
   b) Waves move
   c) The pebble moves
   d) Water moves

   Answer: b

   Explanation: When a pebble is thrown in still water, a circular pattern of alternate crests spread out. The kinetic energy makes the particles to oscillate which comes in contact with it. The energy gets transferred to the particles of the next layer which also begins to oscillate. Thus, it is the disturbance or waves that move forward and not the particles of the medium.

2. Mechanical waves are called elastic waves.
   a) True
   b) False

   Answer: a

   Explanation: Waves which require a medium for their propagation are called mechanical waves. They are also called elastic waves because they depend on the elastic properties of a medium.

3. What are the essential properties a medium must possess for the propagation of mechanical waves?
   a) Stable pressure
   b) Maximum friction
   c) Constant temperature
   d) Minimum friction

   Answer: d

   Explanation: The friction force amongst the particles of the medium should be negligibly small so that they continue oscillating for a sufficiently long time and the wave travels a sufficiently long distance through the medium.

4. Transverse waves can be formed in fluids.

a) True

b) False

Answer: b

Explanation: Transverse waves travel in the form of crests and troughs. They involve changes in the shape of the medium. So they can be transmitted through media which have rigidity. As fluids do not sustain shearing stress, transverse waves cannot be formed in them.

5. Which of the following waves can be transmitted through solids, liquids and gases?

a) Transverse waves

b) Electromagnetic waves

c) Mechanical waves

d) Longitudinal waves

Answer: d

Explanation: Longitudinal waves involve changes in the volume and density of the medium. Since all media can sustain compressive stress, longitudinal waves can be transmitted through all the three types of media.

6. For an aluminium the modulus of rigidity is 2.1×10^{10} N/m^2 and density is 2.7×10^3 kg/m^3. Find the speed of transverse waves in the medium.

a) 27.9×10^3 m/s

b) 2.79×10^3 m/s

c) 25.14×10^3 m/s

d) 24.1×10^3 m/s

Answer: b

Explanation: Speed = $\sqrt{(\eta/p)}$

Speed = 2.79×10^3 m/s.

7. Sound travels through a gas under which of the following condition?

a) Isothermal condition

b) Non-isothermal condition

c) Adiabatic condition

d) Transverse condition

Answer: c

Explanation: The compressions and rarefactions are formed so rapidly that the heat generated in the regions of compressions does not get time to pass into the regions of rarefactions so as to equalize the temperature. So when sound travels through gas, the temperature remains constant. Therefore, it is adiabatic.

8. What kind of wave is formed in organ pipes?
   a) Transverse stationary waves
   b) Electromagnetic waves
   c) Mechanical waves
   d) Longitudinal stationary waves

Answer: d

Explanation: When two identical longitudinal waves travelling in opposite directions overlap, a longitudinal stationary wave is formed. Thus, the waves produced in organ pipes are longitudinal stationary waves.

9. A wave transmits momentum. Can't it transfer angular momentum?
   a) Yes
   b) No

Answer: b

Explanation: A wave transmitting momentum cannot transmit angular momentum because a transfer of angular momentum means the action of a torque which causes rotator motion.

10. What is the most fundamental property of wave?
   a) Temperature
   b) Pressure
   c) Frequency
   d) Wavelength

Answer: c

Explanation: When a wave travels from one medium to other, its wavelength as well as velocity may change. This is the reason that frequency is the fundamental property of a wave.

11. Which of the following is also known as pressure waves?

a) Transverse waves
b) Longitudinal waves
c) Mechanical waves
d) Stationary waves

Answer: b

Explanation: Longitudinal waves travel in a medium as series of alternate compressions and rarefactions and hence are called pressure waves.

12. In which medium sound travels faster?

a) Solid
b) Liquid
c) Gas
d) Water vapour

Answer: a

Explanation: Sound travels in solid with the highest speed because the coefficient of elasticity of solids is much greater than the coefficient of elasticity of liquids and gases.

13. Which is different from others by units?

a) Phase difference
b) Mechanical equivalent
c) Loudness of sound
d) Poisson's ratio

Answer: d

Explanation: Of all the given quantities, Poisson's ratio has no units.

14. The waves, in which the particles of the medium vibrate in a direction perpendicular to the direction of wave motion, is known as ________

a) Transverse waves
b) Longitudinal waves
c) Propagated waves
d) Magnetic waves

Answer: a

Explanation: In transverse waves, particles of the medium vibrate in a direction perpendicular of the wave

15. The waves produced by a motor boat sailing in water are ______

a) Transverse
b) Longitudinal
c) Longitudinal and transverse
d) Stationary

Answer: c

Explanation: Transverse waves are generated on the water surface. Inside water longitudinal waves longitudinal waves are produced due to vibrations of the rudder.

16. For a wave propagating in a medium, identify the property that is independent of the others.

a) Velocity
b) Wavelengths
c) Frequency
d) All these depend on each other

Answer: c

Explanation: Wave velocity=frequency × wavelength
Frequency remains unchanged while velocity and wavelength and interdependent.

17. A boat at anchor is rocked by waves, whose crests are 100m apart and velocity is 25m/s. The boat bounces up once in every ______

a) 2500s
b) 75s
c) 4s
d) 0.25s

Answer: c

Explanation: $\Lambda=100m, v=25m/s$
$T=\Lambda/v=100/25=4s.$

18.A transverse wave passes through a string with the equation

$y=10\sin\pi(0.02x-2t)$

Where x is in metres and t in seconds. What is the maximum velocity of the particles in wave motion?

a) 63m/s
b) 78m/s
c) 100m/s
d) 121m/s

Answer: a

Explanation: $y=10\sin\pi(0.02x-2t)$

$u=dy/dt=-20\pi\cos\pi(0.02x-2t)$

$u_{max}=20\pi=63m/s$.

19. If equation of a sound wave is

$y=0.0015\sin(62.8x+314t)$

Then its wavelength will be ___________

a) 0.1unit
b) 0.2units
c) 0.3unit
d) 2unit

Answer: a

20. The equation of wave is given by

$y=10\sin(2\pi t/30+\alpha)$

If the displacement is 5cm at t=0, then the total phase at t=7.5s will be ___________

a) π/3rad
b) π/2rad
c) 2π/5rad
d) 2π/3rad

Answer: d

Explanation: $y=10\sin(2\pi t/30+\alpha)$

At t=0, $5=10\sin\alpha$ or $\sin\alpha=1/2$

$\alpha=\pi/6$

Total phase at t=7.5s,

$\phi=(2\pi\times7.5)/300+\pi/6=\pi/2+\pi/6=2\pi/3$.

21. If two sound waves having a phase difference of 60°, then they will have a path difference of ___________

a) $\lambda/6$
b) $\lambda/3$
c) λ
d) 3λ

Answer: a

Explanation: $\Delta\phi=60°=\pi/3$
$\Delta x=\lambda/2\pi\times\Delta\phi=\lambda/2\pi\times\pi/3=\lambda/6$.

22. Which of the following does not show any interference pattern?

a) Soap bubble
b) Excessively thin film
c) A thick film
d) Wedge Shaped film

Answer: b

Explanation: An excessively thin film shows no interference pattern because in that case, as the thickness of the film is negligible, the path difference, Δ, between the two reflected rays turns out to be $\lambda/2$ which is the condition of minima. Hence, the pattern is not observed.
The interference pattern is observed in the soap bubble, thick film, and wedge-shaped film.

23. The main principle used in Interference is ______________

a) Heisenberg's Uncertainty Principle
b) Superposition Principle
c) Quantum Mechanics
d) Fermi Principle

Answer: b

Explanation: Superposition principle is the basic principle used in the interference of light. When the incoming light waves superimpose constructively, the intensity increases while when they add destructively, it decreases.

24. When Two waves of same amplitude add constructively, the intensity becomes _____________

a) Double
b) Half
c) Four Times
d) One-Fourth

Answer: c
Explanation: As we know, I ∝ A^2. Thus, as the two waves add constructively, their amplitude becomes twice and hence the intensity becomes four times.

25. The shape of the fringes observed in interference is _____________

a) Straight
b) Circular
c) Hyperbolic
d) Elliptical

Answer: c
Explanation: The fringes observed in an interference pattern are hyperbolic in shape. When the distance between the slits and the screen is large, they appear almost straight.

26. If instead of monochromatic light white light is used for interference of light, what would be the change in the observation?

a) The pattern will not be visible
b) The shape of the pattern will change from hyperbolic to circular
c) Colored fringes will be observed with a white bright fringe at the center
d) The bright and dark fringes will change position

Answer: c
Explanation: When white light is used instead of monochromatic light, all the seven constituent colors produce their interference pattern. At the center of the screen, all the wavelengths meet in phase and, therefore, a white bright fringe is formed. Then the next fringe will be formed due to violet color as the wavelength is shortest for violet color. This will be followed by indigo, blue till red color.

27. Zero order fringe can be identified using ___________

a) White light

b) Yellow light

c) Achromatic light

d) Monochromatic light

Answer: a

Explanation: When the white light is used, the central fringe is white in color while the rest are colored. Thus, the central fringe can be identified using white light.

28. Interference is observed only when the phase difference between the two waves is zero.

a) True

b) False

Answer: b

Explanation: For interference pattern, the phase difference between the two rays must be constant. It is not necessary that the phase difference between the two rays has to be zero.

29. The shape of the pattern depends on the ___________

a) Distance between the slits

b) Distance between the slits and the screen

c) Wavelength of light

d) Shape of the slit

Answer: d

Explanation: The shape of the interference pattern observed depends on the shape of the slits. If the shape of the slits changes, the shape of the fringes changes.

30.A thin sheet of refractive index 1.5 and thickness 1 cm is placed in the path of light. What is the path difference observed?

a) 0.003 m

b) 0.004 m

c) 0.005 m

d) 0.006 m

Answer: c

Explanation: AS we know, the path difference introduced by the sheet = (μ – 1) t, where t is the thickness of the sheet.

Here, μ = 1.5 and t = 0.01 m

Therefore, Δx = 0.5 X 0.01 m

= 0.005 m.

31. According to stoke's law, the expression for maxima is: 2μtcosr =

a) nλ
b) 2nλ
c) (2n + 1) λ/2
d) (n + 1) λ/2

Answer: c

Explanation: Stoke's relation states that when a light ray is incident on the interface of the optically denser medium, then the reflected wave suffers a phase change of π. Thus, for maxima 2μtcosr = (2n + 1) λ/2 and for minima 2μtcosr = nλ.

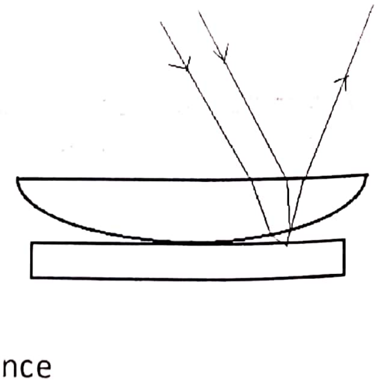
32. The interference pattern of soap bubble changes continuously.

a) True
b) False

Answer: a

Explanation: The top of the soap bubble is excessively thin, while the middle portion is thin and the bottom of the bubble is very thick. Thus, as the thickness varies, the interference pattern varies.

33. Which phenomenon is observed in the following figure?



a) Wedge-Shaped film
b) Destructive Interference
c) Refraction
d) Newton's Rings

Answer: d

Explanation: In the figure, newton's rings would be obtained. The circular fringes would be observed owing to the wedge shaped film on both sides of equal thickness.

34. When a thin plate of refractive index 1.5 is placed in the path of one of interfering beams of Michaelson Interferometer, a shift of 30 fringes is observed. If the thickness of plate is 0.018 mm, the wavelength of the used light is ____________

a) 4000 Å

b) 5000 Å

c) 6000 Å

d) 7000 Å

Answer: c

Explanation: Here, $\mu = 1.5$, $n = 30$, $t = 1.8 \times 10^{-5}$ m

Path difference due to the glass plate = $2(\mu - 1)t$

$2(\mu - 1)t = n\lambda$

$\lambda = 2(\mu - 1)t/n$

$= 2 \times 0.5 \times 1.8 \times 10^{-5}/30$

= 6000 Å.

35. A thin layer of colorless oil is spread over water in a container ($\mu = 1.4$). If the light of wavelength 640 nm is absent in the reflected light, what is the minimum thickness of oil layer?

a) 179.6 nm

b) 198.3 nm

c) 207.6 nm

d) 214.3 nm

Answer: d

Explanation: Let t be the thickness of the oil layer spread on water.

For minima, $2\mu t\cos r = n\lambda$

For minimum thickness, we take $n = 1$.

Therefore, $t_{min} = \lambda/2\mu$

= 600 nm/2.8

= 214.3 nm.

36. In Newton's ring experiment, the diameter of the 10th ring changes from 1.40 to 1.23 cm when a liquid is introduced between the lens and glass plate. What is the refractive index of the liquid?

a) 1.05
b) 1.15
c) 1.25
d) 1.35

Answer: c

Explanation: We know, $D_n^2 = 4n\lambda R/\mu$

Without liquid in air, $\mu = 1$, $D_{10}^2 = 40\lambda R$

With liquid, $D_{10}^{2'} = 40\lambda R/\mu$

Dividing both we get, $\mu = D_{10}^2 \; D_{10}^{2'}$

$= \{1.40/1.27\}^2 = 1.25$.

37. State the essential condition for diffraction of light to occur.

a) The size of the aperture must be less when compared to the wavelength of light
b) The size of the aperture must be more when compared to the wavelength of light
c) The size of the aperture must be comparable to the wavelength of light
d) The size of the aperture should not be compared to the wavelength of light

Answer: c

Explanation: Diffraction is the spreading out of waves as they pass through an aperture or around objects. The diffraction of light occurs when the size of the obstacle or the aperture is comparable to the wavelength of light.

38. What is the cause of diffraction?

a) Interference of primary wavelets
b) Interference of secondary wavelets
c) Reflection of primary wavelets
d) Reflection of secondary wavelets

Answer: b

Explanation: Diffraction occurs due to interference of secondary wavelets between different portions of a wavefront allowed to pass across a small aperture or obstacle. Interference can be either constructive or destructive. When interference is constructive, the intensity of the wave will increase.

39. What should be the order of the size of an obstacle or aperture for diffraction light?

a) Order of wavelength of light
b) Order of wavelength of obstacle
c) Order in ranges of micrometer
d) Order in ranges of nanometer

Answer: a

Explanation: The size of the obstacle or aperture should be of the order of the wavelength of light used. Therefore, the size of an obstacle is not of the order of obstacle, or micrometer or nanometer.

40. A small circular disc is placed in the path of light from a distant source. Identify the nature of the fringe produced.

a) Dual
b) Narrow
c) Dark
d) Bright

Answer: d

Explanation: Waves from the distant source are diffracted by the edge of the disc. These diffracted waves interfere constructively at the center of the shadow and produce a bright fringe. Therefore, the nature of the fringe produced is bright.

41. Single slit diffraction is completely immersed in water without changing any other parameter. How is the width of the central maximum affected?

a) Insignificant
b) Increases
c) Decreases
d) Becomes zero

Answer: c

Explanation: Wavelength of light in water decreases, so the width of the central maximum also decreases. This is the impact on the width of the central maximum when a single slit is completely immersed in water.

42. Diffraction is common in light waves.

a) True
b) False

Answer: b
Explanation: As the wavelength of light is much smaller than the size of the objects around us, so diffraction of light is not easily seen. Therefore, for diffraction of a wave, an obstacle or aperture of the size of the wavelength of light of the wave is needed. As the wavelength of light is of the order of 10-6m and obstacle aperture of this size are rare, diffraction is not common in light waves.

43. Determine the half angular width of the central maximum, if a wavelength of 1000 nm is observed when diffraction occurs from a single slit of 2 μm width.

a) 100°
b) 30°
c) 90°
d) 150°
ANS: B

44. What will be the linear width of the central maximum on a screen that is kept 5 m away from the slit, if a light of wavelength 800 nm strikes a slit of 5 mm width.

a) 1.2 mm
b) 5.6 mm
c) 6.5 mm
d) 9.7 mm
ANS: A

45. Find the focal length of the mirror that forms an image 6.2 cm behind the mirror of an object placed at 26 cm in front of the mirror?

A. −6.58 cm
B. −8.41 cm
C. −7.8 cm
D. −9.6 cm

ANS: B

47. The lens with a long focal length is

A. not strongly curved only
B. thin only
C. thick
D. not strongly curved and thin

ANS: D

48. The power of magnifying glasses given by

A. f + p
B. 1 + d/f
C. d+ f
D. 1 + fd

ANS: B

49. In astronomical compare to eye piece, objective lens has

A. negative focal length
B. zero focal length
C. small focal length
D. large focal length

ANS: D

50. The size of the image is always smaller than the object in

A. convex mirror
B. concave mirror
C. silver mirror
D. plane mirror

ANS: A

51. The lens which is thin at center and thick at edges is

A. convex lens
B. biconvex lens
C. biconcave lens
D. concave lens

Ans: D

52. The projection or converging lens provides

A. inverted image only
B. real image only
C. virtual image
D. inverted and real image

ANS: D

53. The critical angle of water when refracted angle is 90 ° and refractive index for water and air is 1.33 and 1 is

A. 48.8 °
B. 49.1 °
C. 50 °
D. 51 °

ANS: A

54. A convex mirror is used to reflect light from an object placed 30 cm in front of the mirror. If the focal length of the mirror is 20 cm then the location of the image should be

A. −27 cm
B. −37 cm
C. −29 cm

ANS: A

55. One of the angle of a right-angled prism is

A. 30 °
B. 45 °
C. 90 °
D. 60 °

ANS: C

56. Power of a lens is defined as the reciprocal of its

A. focal length in meters
B. principal axis
C. optical center
D. vertex

ANS: A

57. The focus lies behind the mirror in

A. convex mirror
B. concave mirror
C. silver mirror
D. plane mirror

ANS: A

58. [Radius of curvature (R)/2] is equal to

A. focal length(f)
B. center of curvature
C. vertex
D. pole

ANS: A

59. The number of converging lenses that the compound microscope has are

A. 3
B. 2
C. 4
D. 5

ANS: A

60. If an ophthalmologist places a 3.00 diopter lens next to 0.75 diopter lens, the power of lens should be

A. 3 diopters
B. 0.75 diopters
C. 2.25 diopters
D. 3.75 diopters

ANS: D

61. The outer concentric shell in fiber optic is called

A. cladding
B. core
C. coat
D. mantle

ANS: A

62. When a ray of light strikes a face of prism perpendicularly, it enters the prism without deviation and strikes the hypotenuse at an angle of

A. 30 °
B. 45 °
C. 90 °
D. 60 °

ANS: B

63. A window which can transmit all the incident light without any reflection is called

a) Polarized Window
b) Malus Window
c) Brewster Window
d) Non-reflecting window

Answer: c

Explanation: Brewster's window is the practical use of Brewster law. When light is incident on a clean glass plate, most of the incident light (>> 92%) is transmitted while a small fraction is reflected.

64.What should be the phase difference between the two plane-polarized waves, vibrating at right angles to each other, to produce circularly polarized light?

a) π/6
b) π/2
c) π/4
d) π/3

Answer. b

Explanation: The circularly polarized light is produced when the phase difference between the two rays is π/2 and the angle of incidence is π/4. In that case, the equation of the polarized light turns out to be $x^2 + y^2 = a^2$, which is the equation of the circle.

65.Which of the following is a uniaxial crystal?

a) Borax
b) Mica
c) Quartz
d) Selenite

Answer: c

Explanation: Uniaxial crystals are those in which there is only one optic axis. Calcite, quartz, ice are a few examples. Borax, mica, and selenite are biaxial crystals which have two optic axes.

66. If the phase difference between two rays is π/2 and the angle of incidence is not equal to π/4, the emergent light is ___________
a) Linearly Polarized
b) Elliptically Polarized
c) Circularly Polarized
d) Non-Polarized

Answer: B

67. The velocity of light in water is 2.2 X 10^8 m/s. What is the polarizing angle of incidence?
a) 47.23
b) 51.02
c) 53.74
d) 65.36

Answer: c

Explanation: Refractive index of water = Speed of light in space/Speed of light in water
= 3/2.2
= 1.3636
Using Brewster's Law, Angle of incidence = $\tan^{-1}\mu$
= $\tan^{-1}1.3636$
= 53.74.

68. An electromagnetic beam has an intensity 28 W/m^2 and is linearly polarized vertically. What is the intensity of the transmitted beam, if the angle of incidence on the polaroid is 45o with the vertical?
a) 10 Wm^{-1}
b) 12 Wm^{-1}
c) 14 Wm^{-1}
d) 16 Wm^{-1}

Answer: c

Explanation: Here, $I_o = 28\ Wm^{-2}$, $\theta = 45$

Using Malus law, $I = I_o\cos^2\theta$

$I = 28 \times \cos^2 45$, $I = 14\ Wm^{-1}$.

69. What should be the thickness of quarter-wave plate for a light of wavelength 5890 Å if $\mu_e = 1.553$ and $\mu_o = 1.544$?
a) 1.33×10^{-3} cm
b) 1.43×10^{-3} cm
c) 1.53×10^{-3} cm
d) 1.63×10^{-3} cm

ANS: D

70. A tube of length 20cm containing a 10% sugar solution rotates the plane of polarization by 13.2°. What is the specific rotation of sugar solution?
a) 66°
b) 55
c) 44
d) 33

Answer: a

Explanation: The specific rotation is given by $S = 10\theta/lC$

Here, $\theta = 13.2°$, $C = 0.1$ g/cc and $l = 20$ cm

Therefore, $S = 10 \times 13.2/20 \times 0.1$

$= 66°$.

71. Unpolarized light is incident on a plane glass surface. What should be the angle of incidence such that the reflect and refracted rays are perpendicular to each other?
a) 90°
b) 45°
c) 57°
d) 60°

Answer: c

Explanation: Using Brewster's Law, $\mu = \tan i_p$

In this case, $i + r$ is equal to $\pi/2$.

For glass, $\mu = 1.5$

Therefore, $i_p = \tan^{-1}\mu = 57°$.

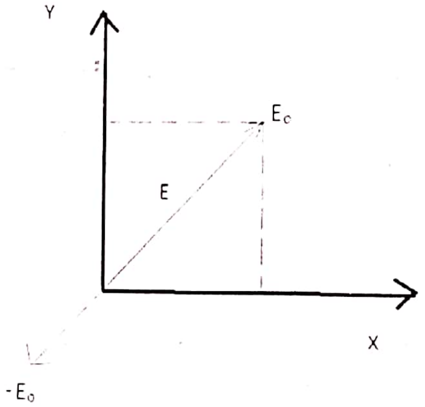
72. A plate which induces the desired amount of phase difference between two rays is known as ____________

a) Polaroid
b) Phasor plates
c) Retardation Plates
d) Quartz plates

Answer: c

Explanation: Sometimes, it is required to induce a certain phase difference between E-ray and O-ray. For that, a plate with a specific thickness is chosen to induce that phase difference. This plate is known as the retardation plate as it retards the motion of one of the rays.

73. What does the following graph show?



a) Linearly Polarized Light
b) Unpolarized Light
c) Partially Polarized Light
d) Circular Polarized Light

Answer: a

Explanation: The graph shows a linearly polarized light. The vibrations are restricted in the x-y plane. Such a polarized light is obtained by using a polarizer/Polaroid and the phenomenon is called polarization of light.

74. What is the ratio of the focal lengths of the two Plano-convex lenses in Huygens's Eyepiece?

a) 2:1
b) 3:1
c) 3:2
d) 4:3

Answer: b

Explanation: The focal lengths of the two Plano-convex lenses in Huygens's Eyepiece are in the ration 3:1(3f and f) and the distance between them is equal to 2f. The focal length and positions of the two lenses are such that the eyepiece is achromatic and free from spherical aberration.

75. Two lenses of focal length 8 cm and 6 cm are placed a certain distance apart. If they form an achromatic combination, the separation between them is __________
    a) 5cm
    b) 6cm
    c) 7cm
    d) 8cm

Answer: c

Explanation: For an achromatic combination, the separation x is given by,

$x = (f1 + f2)/2$

As we know, f1 = 8cm and f2 = 6cm

$x = 14/2$

$x = 7$ cm.

76. An observer is standing stationary in air moving at a speed of 2m/s. A source of frequency 20Hz is moving in the direction of wind with speed 10m/s towards the observer. What will be the frequency as heard by the observer? Speed of sound in air is 330m/s.
    a) 20.62Hz
    b) 19.40Hz
    c) 21.68Hz
    d) 22.63Hz

Answer: a

Explanation: As the air is moving, we can solve this question from the air's frame of reference. From the air's frame of reference, the observer will be going towards the observer at 2m/s and the source will be coming towards the observer at 10-2 = 8m/s.

$F = f(v+v_0)/(v+v_8)$

$= 20(330+2)/(330-8)$

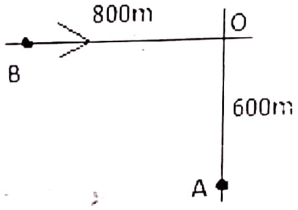
$= 20*332/322 = 20.62$Hz.

77. A train with a frequency 'f'. What will be the frequency heard by a person sitting in the train? Speed of the train is 'v'.
a) f
b) f(330+v)/330
c) fv/(330-v)
d) fv/(330+v)

Answer: a

Explanation: There is no relative motion between the source and observer, thus the frequency heard by the person will be the original frequency of the whistle.

78. A passenger is standing on a platform. A train is arriving with speed =100m/s. It whistles at point B while the passenger is at point A. What is the frequency heard by the passenger if the whistle frequency is 100Hz? Speed of sound = 330m/s.



a) 132Hz
b) 80.48Hz
c) 124Hz
d) 164Hz

Answer: a

Explanation: We will consider the component of train speed along line AB, which is
= 100*(800/1000) = 80m/s.
Freq = 100(330)/(330-80) = 132Hz.

79. A source of sound moves towards an observer. What happens to the speed of sound in the medium?
a) Increases
b) Decreases
c) Remains the same
d) Depends on speed with which source moves

Answer: c

Explanation: Speed of sound in the medium depends on the properties of the medium like bulk modulus and density, not on the speed of source creating the sound.

80. A source moves towards a stationary observer with a speed of 10m/s. If the frequency of the source is 10Hz what will be the wavelength of sound heard by the observer? Speed of sound = 330m/s.

a) 32m
b) 34m
c) 33m
d) 31m

Answer: a

Explanation: Apparent frequency F = f(330+v_0)/(330+v_8)
= 10(330)/(330-10) = 10.31Hz.
Wavelength = 330/F
= 330/10.31
= 32.007m = 32m.

81. A source of frequency 50Hz is moving towards an observer with a deceleration of 2m/s^2. If its initial speed is 20m/s, what will be the maximum frequency heard by the observer? Initial distance between source and observer is 100m. Speed of sound = 330m/s.

a) 47.14Hz
b) 0
c) 53.22Hz
d) 53.03Hz

Answer: c

Explanation: Apparent frequency only depends on velocity and not the distance between source and observer. So, maximum frequency will be heard when speed is maximum, which is at the start. F = 50(330)/(330-20) = 53.22Hz.

82. A man jumps from a building with a source of sound. When he reaches halfway down, he starts the siren of frequency 100Hz. A person standing below him on the ground hears the first sound to be of frequency 120Hz. What is the height of the building? Speed of sound = 330m/s. Take g=9.81m/s^2.

a) 154m
b) 308m
c) 77m
d) 500m

Answer: b

Explanation: We can find the speed corresponding to the apparent frequency and then use that to find the height of the building.
120 = 100(330)/(330-v) v = 330 – 3300/12 = 55m/s.
Using, $v^2 = 2gh$, we can find the height covered by the man. The double of this value will be the height of the building as he is mid-way.
$55^2 = 2*9.81*h$ h = 154m Height of building = 2h = 308m.

83. If both the source of sound and observer are moving, the apparent frequency will be different from the actual frequency. True or False?
a) True
b) False

Answer: b

Explanation: If relative motion between source and observer is zero there will be no change in frequency heard by the observer. Apparent frequency only varies in case of relative motion. So the given statement is false.

84. A man is moving towards a wall with a source of sound in his hand. Frequency of source = 50Hz. Speed of man = 8m/s. If the man sends one pulse of sound, what will be the frequency heard by him after sound reflects off the wall? Speed of sound = 330m/s.
a) 53.86Hz
b) 52.48Hz
c) 51.24Hz
d) 52.45Hz

Answer: b

Explanation: First we find frequency heard by wall.
That will be 50(330)/(330-8) = 51.24Hz.
Now, this will act as source and man will be the listener.
So, the frequency heard by the man
= 51.24(330+8)/330
= 52.48Hz.

THERMODYNAMICS AND STATISTICAL PHYSICS

[Laws of Thermodynamics and Their Applications, Statistical Interpretation of Thermodynamics, ensembles, kinetic theory, ideal gases, equation of state)

1. Which of the following can be regarded as gas so that gas laws could be applicable, within the commonly encountered temperature limits.

(a) 02, N2, steam, C02
(b) Oz, N2, water vapour
(c) S02, NH3, C02, moisture
(d) 02, N2, H2, air
(e) steam vapours, H2, C02.
Ans: d

2. According to kinetic theory of gases, the absolute zero temperature is attained when

(a) volume of the gas is zero
(b) pressure of the gas is zero
(c) kinetic energy of the molecules is zero
(d) specific heat of gas is zero
(e) mass is zero.
Ans: c

3. The pressure 'of a gas in terms of its mean kinetic energy per unit volume E is equal to

(a) E/3
(b) E/2
(c) 3E/4
(d)2E/3
(e) 5E/4.
Ans: d

4. Superheated vapour behaves

(a) exactly as gas
(b) as steam
(c) as ordinary vapour
(d) approximately as a gas
(e) as average of gas and vapour.
Ans: d

5. No liquid can exist as liquid at
   (a) – 273 °K
   (b) vacuum
   (c) zero pressure
   (d) centre of earth
   (e) in space.
   Ans: c

6. Specific heat of air at constant pressure is equal to
   (a) 0.17
   (b) 0.21
   (c) 0.24
   (d) 1.0
   (e) 1.41
   Ans: c

7. The ratio of two specific heats of air is equal to
   (a) 0.17
   (b) 0.24
   (c) 0.1
   (d) 1.41
   (e) 2.71.
   Ans: d

8. Work done in a free expansion process is
   (a) + ve
   (b) -ve
   (c) zero
   (d) maximum
   (e) minimum.
   Ans: c

9. On weight basis, air contains following parts of oxygen
   (a) 21
   (b) 23
   (c) 25
   (d) 73
   (e) 79.
   Ans: b

10. A perfect gas at 27°C is heated at constant pressure till its volume is double. The final temperature is

(a) 54°C
(b) 327°C
(c) 108°C
(d) 654°C
(e) 600°C

Ans: b

11. If a certain amount of dry ice is mixed with same amount of water at 80°C, the final temperature of mixture will be

(a) 80°C
(b) 0°C
(c) 40°C
(d) 20°C
(e) 60°C.

Ans: b

12. In a non-flow reversible process for which p = (- 3V+ 15) x 105N/m2,V changes from 1 m to 2 m3. The work done will be about

(a) 100 xlOO5 joules
(b) lxlO5 joules
(c) 10 xlO5 joules
(d) 10 xlO5 kilo joules
(e) 10xl04kiojoules.

Ans: c

13. The value of the product of molecular weight and the gas characteristic constant for all the gases in M.K.S. unit is

(a) 29.27 kgfm/mol°K
(b) 8314kgfm/mol°K
(c) 848kgfm/mol°K
(d) 427kgfm/mol°K
(e) 735 kgfm/mol°K.

Ans: c

14. On volume basis, air contains following parts of oxygen

(a) 21
(b) 23
(c) 25
(d) 77
(e) 79

Ans: a

15. The value of the product of molecular weight and the gas characteristic constant for all the gases in S.I. units is

(a) 29.27 J/kmol°K
(b) 83.14J/kmol°K
(c) 848J/kmol°K
(d) All J/kmol °K
(e) 735 J/kmol °K.

Ans: b

16. Minimum work in compressor is possible when the value of adiabatic index n is equal to

(a) 0.75
(b) 1
(c) 1.27
(d) 1.35
(e) 2.

Ans: b

17. Molecular volume of any perfect gas at 600 x 103 N/m2 and 27°C will be

(a) 4.17m3/kgmol
(b) 400 m3/kg mol
(c) 0.15 m3/kg mol
(d) 41.7 m3/kg mol
(e) 417m3/kgmol.

Ans: a

18. A gas is compressed in a cylinder by a movable piston to a volume one-half its original volume. During the process 300 kJ heat left the gas and internal energy remained same. The work done on gas in Nm will be

(a) 300 Nm
(b) 300,000 Nm
(c) 30 Nm
(d) 3000 Nm
(e) 30,000 Nm.
Ans: b

19. An engine operates between temperatures of 900°Kandr2 and another engine between T2 and 400°K For both to do equal work, value of T2 will be
(a) 650°K
(b) 600°K
(c) 625°K
(d) 700°K
(e) 750°K.
Ans: a

20. A manufacturer claims to have a heat engine capable of developing 20 h.p. by receiving heat input of 400 kcal/mt and working between the temperature limits of 227° C and 27° C. His claim is
(a) justified
(b) not possible
(c) may be possible with lot of sophistications
(d) cost will be very high
(e) theroretically possible.
Ans: b

21. I kgf/cm2 is equal to
(a) 760 mm Hg
(b) zero mm Hg
(c) 735.6 mm Hg
(d) 1 mm Hg
(e) lOOmmHg. [**Ans: c**]

22. One barometric pressure or 1 atmospheric pressure is equal to
(a) 1 kgf/cnr2
(b) 1.033 kgf/cm2
(c) 0 kgf/cm2
(d) 1.0197 kgf/cm2
(e) 100 kgf/cm2. [**Ans: b**]

23. The equation for the average kinetic energy is________

a) 0.5 KT

b) 1.5 KT

c) 2.5 KT

d) 3.5 KT

Answer: **b**

Explanation: The equation for kinetic energy is $0.5mv^2$, where m= mass and v= velocity. This equation corresponds to 1.5 KT, where K=Boltzmann's constant and R= Gas constant.

24. What will be the value of temperature of hot reservoir in a carnot cycle, if the temperature of cold reservoir is 25°C, heat absorbed from hot reservoir is 12J and heat rejected to cold reservoir is 4J?

a) 684K

b) 333.33K

c) 894K

d) 433.33K

Answer: **c**

Explanation: For a carnot cycle: $Q_2/Q_2 = T_2/T_1$.

$T_2 = 12/4 * 298 = 894K$.

25. A carnot engine extracts 1200J of energy from a hot reservoir. What is the amount of work done by it? Temperatures of hot and cold reservoirs are 200K and 150K respectively.

a) 800J

b) 900J

c) 600J

d) 850J

Answer: **b**

Explanation: The efficiency of a carnot engine is:

$1- T_2/T_1 = 1-150/200 = 1/4$.

Efficiency is also given by: $1 - Q_2/Q_1 = 1 - Q_2/1200 = 1/4$.

$Q_2 = 3/4 *1200 = 900J$.

26. The efficiency of a carnot engine is 50%. The temperature of the hot reservoir is kept constant. By what amount should the temperature of the cold reservoir be decreased so that efficiency becomes 60%.

a) 1K
b) 2K
c) 30K
d) 83K

Answer: a
Explanation: $0.5 = 1 - T_C/T_H$.
And $0.6 = 1 - (T_C + x)/T_H$.
From the first equation we get: $5/10 = T_C/T_H$.
From the second equation we get: $4/10 = (T_C + x)/T_H$.
Now, we see that the value of x must be 1K.

27. If an engine takes 5J of heat energy from a reservoir and rejects 3J to the surroundings, what is its efficiency?
a) 2/5
b) 3/5
c) 1/5
d) 0

Answer: a
Explanation: Efficiency is defined as work done/heat input.
Work done = 5-3=2J.
Heat input = 5J.
Thus, efficiency = 2/5.

28. An engine works between 2 reservoirs of temperature 500K and 300K. A company claims that this engine of theirs takes 200J of energy from the hot reservoir and rejects 110J of energy. Is this True or False?
a) True
b) False
Answer: b
Explanation: The maximum possible efficiency is given by:
$1 - T_{cold}/T_{hot} = 1 - 300/500 = 0.4$.
The company claims that their engine has an efficiency of (200-110)/200 = 0.45.
This is not possible as maximum efficiency is 0.4.

29. A box contains 10^5 molecules. The average kinetic energy of each molecule is $0.5*10^{-6}$J. With respect to an observer at rest the box, having a mass of 1kg, is moving with a velocity of 2m/s. What is the value of kinetic energy that will contribute to the internal energy?

a) 0.05J
b) 2.05J
c) 0
d) 2J

Answer: a

Explanation: When calculating internal energy of molecules, the system is to be studied from a frame in which the centre of mass is at rest. So, the kinetic energy due to movement of the entire box will not be considered. Only the individual kinetic energies of molecules will be considered, and their value is: $10^5*0.5*10^{-6}$
= 0.05J.

30. A body has 15J of heat energy in a particular state. At the same state it has an internal energy of 30J. Assume no work is done, what will happen to the internal energy if 5J of heat is added to the system?

a) Heat energy = 20J, Internal energy = 35J
b) Heat energy = 15J, Internal energy = 30J
c) Heat energy = 15J, Internal energy = 35J
d) A body cannot have heat energy in a particular state

Answer: d

Explanation: Heat energy is the energy in transit. A system's state cannot be defined by heat energy, it is defined by internal energy. Heat and work are path functions. Heat can be supplied or removed from a system but can't define a system in a state.

31. Maxwell-Boltzmann law is for the ________

a) Distinguishable particles
b) Indistinguishable Particles
c) Particles with half integral spin
d) Particles with integral spin **[Answer: a]**

Explanation: The Maxwell-Boltzmann statistics is for the distinguishable particles, which are basically the classical particles like atoms and molecules.

32. What would be the most probable velocity for one Oxygen molecule at 300 K?

a) 612 m/s
b) 714 m/s
c) 798 m/s
d) 821 m/s

ANS: B

33. Mass of A is 4 times that of B. What is the ratio of their mean velocities?

a) 1 : 4
b) 4 : 1
c) 1 : 2
d) 2 : 1

ANS: C

34. What is the Kinetic Energy of 2 g of oxygen at -23°C?

a) 186.2 J
b) 194.86 J
c) 201.45 J
d) 256.32 J

Answer: b
Explanation: As we know, KE = 3nRT/2
Here, T = 250 K and R = 8.314 J/K
N = 2/32 = 1/16 mol
Therefore, KE = 3 X 8.314 X 250/32
= 194.86 J.

35. What is the rms speed of methane at 27°C?

a) 450 m/s
b) 532 m/s
c) 678 m/s
d) 745 m/s

ANS: C

36. On which factor does the average kinetic energy of gas molecules depend?

a) Nature of the gas
b) Temperature
c) Volume
d) Mass

Answer: b

Explanation: The average kinetic energy of a gas molecule depends only on the absolute temperature of the gas and is directly proportional to it.

37. The ration of the speed of sound in nitrogen gas to that in helium gas, at 300 K is?

a) √(2/7)
b) √(1/7)
c) √3/5
d) √6/5

ANS: C

38. Cooking gas containers are kept in a lorry moving with uniform speed. The temperature of the gas molecules inside will ___________

a) Increase
b) Decrease
c) Remain the same
d) Decreases for some, while the increase for others

Answer: c

Explanation: The centre of mass of the gas molecules moves with uniform speed along with the lorry. As there is no change in relative motion, the translational kinetic energy and hence the temperature of the gas molecules will remain the same.

39. For Boyle's law to hold good, the gas should be ___________

a) Perfect and of constant mass and temperature
b) Real and of constant mass and temperature
c) Perfect and at constant temperature but variable mass
d) Real and at constant temperature but variable mass

Answer: a

Explanation: Boyle's law is valid for a constant mass of a perfect gas at a given temperature.

40. A gas behaves as an ideal gas at ________

a) Low pressure and high temperature
b) Low pressure and low temperature
c) High pressure and low temperature
d) High pressure and high temperature

Answer: a

Explanation: A gas behaves as an ideal gas at low pressure and high temperature when the attractive forces between the molecules become negligible.

41. The temperature of gas is held constant, while its volume is decreased. The pressure exerted by the gas on the wall of the container increases, because of its molecules ___________

a) Strike the walls with higher velocities
b) Strike the walls with large farce
c) Strike the walls more frequently
d) Are in contact with the walls for a shorter time

Answer: c

Explanation: When the volume is decreased, the gas molecules strike the walls more frequently.

42. A bulb contains one mole of hydrogen mixed with one mole of oxygen at temperature T. The ratio of rms values of velocity of hydrogen molecules to that of oxygen molecules is?

a) 1:16
b) 1:4
c) 4:1
d) 16:1

Answer: c

Explanation: $v_{rms}=\sqrt{(RT/m)}$

For constant temperature,

$(v_{rms}(H_2))/(v_{rms}(O_2))=\sqrt{(M_{(O2)}/M_{(H2)})}=\sqrt{(32/2)}=4:1.$

43. The degree of freedom of a triatomic gas is?

a) 1
b) 2
c) 6
d) 8

Answer: c

Explanation: A triatomic gas molecule has 3 degrees of freedom due to translator motion and 3 degrees of freedom due to rotator motion.

44. Let A & B are two sample of ideal gases of equal mole .let T be the temperature of both the gas Let EAEA and EBEB are there total energy respectively .Let MAMA and MBMB are these respective Molecular Mass .which of these is true

a. EA>EB

b. EA<EB

c. EA=EB

d. none of these

ANS: C

45. Equal Number of molecules of hydrogen & Oxygen are contained in a vessel at one atmosphere

pressure. The ratio of the collision frequency of hydrogen molecules to the of Oxygen molecules on the

container

a. 1:4

b. 4:1

c. 1:16

d. 16:1

ANS: B

Explanation:

n_1 = Vrms / 2L ---Hydrogen

n_2 = Vrms/2L ---Oxygen

n_1/n_2 = Vrms of Hydrogen/ Vrms of oxygen

Vrms of Hydrogen/ Vrms of oxygen = $(M_O/M_H)^{1/2}$

So $n_1/n_2 = 4:1$

46. M moles of a ideal polyatomic gas($C_v=7R/2$) are in cylinder at temperature T.A heat Q is supplied to the gas. Some M/3 moles of the gas dissociated into atoms while temperature remains constant. Find the correct relation

(a) 3Q=4MRT

(b) 2Q=3MRT

(c) Q=4MRT

(d) 7Q=4MRT

ANS: a

47. There are two statement about Ideal gases

Statement A The V_{rms} of gas molecules depends on the mass of the gas molecule and the temperature

Statement B The V_{rms} is same for all the gases at the same temperature

which one of the following is correct

a. A and B both

b. A only

c. B only

d. A and B both are incorrect

ANS: A

48. For an ideal gas, incorrect statement is

a) Molecules do not occupy any space

b) No attractive force exist between the molecules

c) The gas molecules move in random, straight line motion

d) None of the mentioned

Answer: d

Explanation: Conditions for a gas to behave as predicated by the ideal gas law.

49. What is the volume of 20 gms of Oxygen in Litre at standard conditions?

a) 10

b) 12

c) 14

d) 16

Answer: c

Explanation: At standard conditions, 1 mole of of gas occupy 22.4 litre volume.

50. What is the density of Carbon-di-oxide in kg/m3 at 27 degree celcius and 100 KPa?

a) 1.76

b) 2.76

c) 3.76

d) 4.76

Answer: a

Explanation: density = (Pressure*Molecular weight)/(Gas constant*Temperature).

51. Usually while measuring the specific gravity of a gas, the reference gas that is taken is air.
The above given statement is-
a) False
b) True
c) Depends on the gas
d) None of the mentioned

Answer: b

Explanation: Air is usually taken at the same temperature and pressure.

52. What is the volume of 2.5 gm moles Nitrogen gas at STP? At 100 KPa pressure and 300 K temperature, 2 gm moles of the gas occupy 20 cubic meter volume.
a) 11.23
b) 22.46
c) 33.69
d) 44.92

Answer: d

Explanation: P1V1/n1T1 = P2V2/n2T2.

53. Which one has the lowest density at room temperature?
a) Ne
b) N2
c) NH3
d) CO

Answer: c

Explanation: NH3 have minimum molecular weight.

54. At standard conditions, what is the volume of 1 kg mole of ideal gas?
a) 22.4 m3
b) 2240 m3
c) 224000 m3
d) None of the mentioned

Answer: a

Explanation: V = nRT/P.

55. The value of cp and cv depend on
a) temperature of the gas
b) γ and R
c) pressure of the gas
d) all of the mentioned

Answer: b

Explanation: The value of cp and cv depends on the number of atoms in a molecule and the molecular weight of the gas.

56. Polytropic specific heat is given by cn=cv(γ-n)/(1-n) .
a) true
b) false

Answer: a

Explanation: The polytropic specific heat is used in the relation Qr=cn*ΔT.

57. The value of universal gas constant is
a) 8.2353
b) 8.3143
c) 8.5123
d) none of the mentioned

Answer: b

Explanation: This value comes from the Avogadro law when we put p=760 mm Hg = 1.013*10^5 N/m^2 , T=273.15 K , v=22.4 m^3/kgmol.

58. Characteristic gas constant is given by (here cp=specific heat at constant pressure and cv is the specific heat at constant volume)
a) R=cv – cp
b) R=cp + cv
c) R=cp – cv
d) none of the mentioned
Answer: c
Explanation: Δh=(cv+R)ΔT = cp*ΔT.

59. What is the shape of a P-T curve for ideal gas?

a) Straight line
b) Parabolic
c) Hyperbolic
d) Ellipse

Answer: a

Explanation: P-T curve is a straight line for ideal gas.

60. What is the shape of a V-T curve for ideal gas?

a) Straight line
b) Parabolic
c) Hyperbolic
d) Ellipse

Answer: a

Explanation: V-T curve is straight line for ideal gas.

61. What is the pressure of a 5 liter/mole ideal gas at temperature 27°C?

a) 2.5 atm
b) 3.8 atm
c) 4.4 atm
d) 5.3 atm

Answer: d

Explanation: PV = nRT, => P*5 = 0.0821*300, => P = 5.3 atm.

62. What is the Temperature of a 2 liter/mole ideal gas with pressure 10 atm?

a) 243.6 K
b) 268.4 K
c) 289.1 K
d) 313.5 K

Answer: a

Explanation: PV = nRT, => 10*2 = 0.0821*T, => T = 243.6 K.

63. First of the two ideal gases has twice molar volume as much as the second at same temperature, what is the ratio of their pressures?

a) 4:1
b) 1:4
c) 2:1
d) 1:2

ANS: D

64. 88 grams of CO_2 at 27°C is applying 5 atm pressure, what is the volume occupied by it?

a) 5.6 liter
b) 7.9 liter
c) 9.8 liter
d) 12.2 liter

Answer: c

Explanation: n = 88/44 = 2, PV = nRT, => 5*V = 2*0.0821*300, => V = 9.8 liter.

65. What is the density of O_2 at 27°C with pressure 1 atm?

a) 1.1 g/L
b) 1.3 g/L
c) 1.5 g/L
d) 1.7 g/L

Answer: b

Explanation: Molecular wt. of O_2= 44 g, PV = nRT, => PV = (m/M)RT, => d = PM/RT = (1*32)/(0.0821*300) = 1.3 g/L.

66. What is the molecular mass of an ideal gas with pressure 1 atm, and density 10 g/L at temperature 27°C?

a) 84.5 g
b) 135.1 g
c) 186.8 g
d) 246.3 g

Answer: d

Explanation: M = dRT/P = 10*0.0821*300/1 = 246.3 g.

67. What is the specific gravity of CO_2 at 27°C and pressure 1 atm with respect to air of with density 1 g/L?

a) 1.23
b) 1.55
c) 1.78
d) 1.96

Answer: c

Explanation: Density of CO_2 = PM/RT = 1*44/(0.0821*300) = 1.78 g/L, => Specific gravity = 1.78/1 = 1.78.

68. What is the specific gravity of CO at 27°C and pressure 5 atm with respect to air (molecular wt. = 29 g) at 27°C and pressure 10 atm?

a) 0.48
b) 0.56
c) 0.64
d) 0.72

Answer: a

Explanation: Density of CO = 5*28/(0.0821*300) = 5.68 g/L, density of air = 10*29/(0.0821*300) = 11.77 g/L, => specific gravity = 5.68/11.77 = 0.48.

69. What is the compressibility factor for an ideal gas?

a) 1
b) 2
c) 3
d) Depends on the gas

Answer: a

Explanation: Compressibility of an ideal gas is always 1.

70. Which of the following is not the unit of R?

a) Atm.liter/K.mole
b) Pa.m^3/K
c) N.Kg.m^3/K.mole
d) None of the mentioned

Answer: c

Explanation: N.Kg.m/K.mole is the unit of R.

71. Which of the following is not an example of an Ideal solution?

a) Benzene + Toluene

b) n-Hexane + n-Heptane

c) Ethyl alcohol + Water

d) Ethyl bromide + Ethyl chloride

Answer: c

Explanation: An ideal solution may be defined as the solution in which no volume change and no enthalpy change take place on mixing the solute and the solvent in any proportion. Ethyl alcohol + Water is a Non-Ideal solution.

72. Which of the following is not an example of a non-ideal solution showing negative deviation?

a) HNO_3 + Water

b) HCl + Water

c) Acetic acid + Pyridine

d) Carbon tetrachloride + Toluene

Answer: d

Explanation: HNO_3 + Water, HCl + Water and Acetic acid + Pyridine are non-ideal solutions showing negative deviations. Carbon tetrachloride + Toluene is an example of non-ideal solution showing positive deviation.

73. Which of the following cannot form an azeotrope?

a) $H_2O + C_2H_5OH$

b) $CHCl_3 + C_2H_5OH$

c) $HCl + H_2O$

d) Benzene + Toluene

Answer: d

Explanation: $H_2O + C_2H_5OH$ forms an azeotrope with a boiling point of 351.15 K. $CHCl_3 + C_2H_5$ OH forms an azeotrope with a boiling point of 332.3 K. $HCl + H_2O$ forms an azeotrope with a boiling point of 383 K. Benzene + Toluene is an ideal solution and hence does not form an azeotrope.

74. For the ideal gas equation, what assumptions are made?

a) there is little or no attraction between the molecules of the gas

b) the volume occupied by the molecules is negligibly small compared to the volume of the gas

c) both of the mentioned

d) none of the mentioned

Answer: c

Explanation: The ideal gas equation pv=RT is established from the postulates of the kinetic theory of gases considering these two assumptions.

75. The real gases deviate from the ideal gas equation when the pressure increases.

a) true
b) false

Answer: a

Explanation: With increase in pressure, the intermolecular forces of attraction and repulsion increase, and also the volume of the molecules becomes appreciable compared to the gas volume.

76. For an ideal gas, Z has the value

a) 0
b) 2
c) 1
d) infinity

Answer: c

Explanation: For an ideal gas, pv=RT hence Z=1.

77. The magnitude of Z at a particular pressure and temperature indicates the extent of deviation of the gas from the ideal gas behaviour.

a) true
b) false

Answer: a

Explanation: This is a basic fact about the compressibility factor.

78. According to Avogadro's law, volume of a g mol of all gases at the pressure of ____ and temperature of ____ is same.

a) 760 mm Hg, 100 degree Celsius
b) 760 mm Hg, 0 degree Celsius
c) 750 mm Hg, 100 degree Celsius
d) 750 mm Hg, 0 degree Celsius

Answer: b

Explanation: This is the Avogadro law and these temperature and pressure condition is know as normal temperature and pressure(NTP).

79. At NTP, the volume of a g mol of all gases is(in litres)
a) 22.1
b) 22.2
c) 22.3
d) 22.4

Answer: d

Explanation: This comes from the Avogadro's law.

80. The equation of state is a functional relationship between
a) pressure
b) molar or specific volume
c) temperature
d) all of the mentioned

Answer: d

Explanation: It is expressed in the form f(p,v,T)=0.

81. How many equations are related to solving a flow field?
a) 2
b) 3
c) 5
d) 4

Answer: c

Explanation: There are 5 equations related to solving a flow field.

82. Among the unknowns of a flow field, some of the properties are given below. Which set contains only thermodynamic properties?
a) Density, pressure, specific internal energy, temperature
b) Density, velocity, specific internal energy, temperature
c) Velocity, pressure, specific internal energy, temperature
d) Density, pressure, specific internal energy, Velocity

Answer: a

Explanation: Velocity is a property completely related to fluid flow. The other properties – density, pressure, specific internal energy and temperature are thermodynamic.

83. Fluid velocity is very high. Will thermodynamic equilibrium be applicable to fluid flows?

a) Yes, the external conditions help them stay in thermodynamic equilibrium

b) No, their flow properties change abruptly

c) No, they are influenced by external conditions

d) Yes, the fluid can thermodynamically adjust itself quickly to be in thermodynamic equilibrium

Answer: d

Explanation: The velocity of fluid flow is very high. This may affect their thermodynamic equilibrium. But, the particles are small enough to thermodynamically adjust themselves to equilibrium so quickly.

84. Let,

ρ → Density

T → Temperature

i → Specific internal energy

How can we represent i of a perfect gas in terms of ρ and/or T?

a) $i=T$

b) $i \propto (1/T)$

c) $i=(1/T)$

d) $i \propto T$

Answer: d

Explanation: $i=C_v T$ is the relation between temperature and specific internal energy (where C_v is the specific heat at constant velocity). This can be used to get the energy equation in terms of specific internal energy.

85. Real gases conform more closely with the van der Waals equation of state than the ideal gas equation of state.

a) true

b) false

Answer: a

Explanation: This happens particularly at higher pressures.

86. The magnitude of Z at a particular pressure and temperature indicates the extent of deviation of the gas from the ideal gas behaviour.

a) true

b) false

Answer: a

Explanation: This is a basic fact about the compressibility factor.

87. Which of the following can be measured by LVDT?

A. Displacement

B. Velocity

C. Acceleration

D. All of the mentioned

Answer: D

Explanation: LVDT can measure displacement, velocity and acceleration which is a linear variable differential transformer and inductive transducer.

88. Which of the following is the output of a thermocouple?

A. Alternating current

B. Direct current

C. A.C. voltage

D. D.C. voltage

Answer: D

Explanation: Thermocouple is the device that is used to convert the change in temperature gives output in DC form.

QUANTUM MECHANICS

[Basics Concepts, Schrödinger Equation and its Solutions, Harmonics Oscillator, Hydrogen Atom, Angular momentum and spin, Perturbation theory]

1. Which of the following is the correct expression for the steady-state form of Schrödinger wave function?

a) $P\Psi = -i\frac{h}{2m}\frac{\partial\Psi}{\partial x} + U\Psi$

b) $E\Psi = -i\frac{h}{2m}\frac{\partial^2\Psi}{\partial x^2} + U\Psi$

c) $E\Psi = -i\frac{h^2}{2m}\frac{\partial\Psi/\partial x}{+}U\Psi$

d) $E\Psi = -i\frac{h^2}{2m}\frac{\partial^2\Psi}{\partial x^2} + U\Psi$

ANS: D

2. Which function is considered independent of time to achieve the steady state form?

a) Ψ
b) dΨ/dt
c) $d^2\Psi/dx^2$
d) U

Answer: d

Explanation: The potential energy of a particle is considered to not depend on time explicitly, the forces that act on it, and hence U, vary with the position only.

3. The Energy levels are proportional to _______________

a) n
b) n^{-1}
c) n^2
d) n^{-2}

Answer: d

Explanation: The energy levels for which the Schrodinger's steady state equation can be solved is inversely proportional to the square of quantum number.

4. Total Energy is quantized but not angular momentum of the quantum particle.
   a) True
   b) False

ANS: B

5. Which quantity is said to be degenerate when $H\Psi_n = E_n\Psi_n$?
   a) Eigen Vectors
   b) Eigen Values
   c) Eigen Functions
   d) Operators

Answer: c
Explanation: In such a case, when there is corresponding to each Eigen value there is only one Eigen function, the Eigen function is known as degenerate.

6. For a box with infinitely hard walls, the potential is maximum at ____________
   a) L
   b) 2L
   c) L/2
   d) 3L

Answer: a
Explanation: In a box with infinitely high barriers with infinitely hard walls, the potential is infinite when x = 0 and when x = L.

7. The bob of the pendulum moves faster at the lowest position for a larger amplitude.
   a) True
   b) False

Answer: a
Explanation: We know that the velocity of a simple pendulum is maximum at the lowest position and is given by
$v_{max}=\omega A$
That is for larges amplitude, the bob of the pendulum would move faster.

8. The total energy of a particle executing simple harmonic motion is __________

a) $\propto x$
b) $\propto x^2$
c) Independent of x
d) $\propto \sqrt{x}$

Answer: c
Explanation: $E=2\pi^2 m v^2 A^2$
Clearly, the total energy is independent of displacement x.

9. A body executes simple harmonic motion. The potential energy, the kinetic energy and total energy are measured as a function of displacement x. Which of the following statements is true?

a) Kinetic energy is maximum when $x = 0$
b) Total energy is zero, when $x = 0$
c) Kinetic energy is maximum when x is maximum
d) Potential energy is maximum when $x = 0$

Answer: a
Explanation: The kinetic energy of a simple harmonic oscillator is maximum when $x = 0$.

10. Two simple motions are represented by
$y_1=5(\sin 2\pi t+\sqrt{3}\cos 2\pi t)$
$y_2=5\sin(2\pi t+\pi/4)$
The ratio of the amplitude of two simple harmonic motions is?

a) 1:1
b) 1:2
c) 2:1
d) 1:$\sqrt{3}$

Answer: c
Explanation: $y_1=5\times 2(\sin 2\pi t\cos(\pi/3)+\sin(\pi/3)\cos 2\pi t)$
$y_1=10\sin(2\pi t+(\pi/3))$
$y_2=5\sin(2\pi t+(\pi/4))$
$A_1/A_2 = 10/5=2:1$.

11. The ratio of frequencies of two pendulums is 2:3 then their lengths are in ratio ______

a) $\sqrt{(2/3)}$
b) $\sqrt{(3/2)}$
c) 4/9
d) 9/4

Answer: d
Explanation: $v_1/v_2 = \sqrt{(l_2/l_1)}$
$l_1/l_2 = ((v_2)^2)/((v_1)^2)=9/4$.

12. For a particle executing simple harmonic motion, which of the following statements is not correct?

a) Total energy is always directed toward a fixed point
b) Restoring force is always directed towards a fixed point
c) Restoring force is maximum at the extreme positions
d) Acceleration of the particle is maximum at the equilibrium position

Answer: d
Explanation: At the equilibrium position, the velocity of a particle in simple harmonic motion is maximum and consequently its acceleration is minimum.

13. If a spring of mass 30kg has a spring constant of 15N/m, then its time period is ______

a) 2πs
b) $2\sqrt{2}\ \pi$s
c) $2\sqrt{2\pi}$ s
d) $2\sqrt{2}$ s

Answer: b
Explanation: $T=2\pi\sqrt{(m/k)}$
$T=2\pi\sqrt{(30/15)}=2\pi\sqrt{2}$ s.

14. Statement: Water in a U-tube executes simple harmonic motion. The time period for mercury filled up to the same height in the U-tube be greater than that in case of water.
Reason: The amplitude of an oscillating pendulum goes on increasing.

a) Both statement and reason are true and the reason is the correct explanation of the statement
b) Both statement and reason are true but the reason is not the correct explanation of the statement
c) Statement is true, but the reason is false
d) Statement and reason are false

Answer: d
Explanation: Both the statement and reason are false. Period of oscillation of a liquid in a U-tube is independent of the density of the liquid. The amplitude is the oscillating pendulum decreases due to air friction.

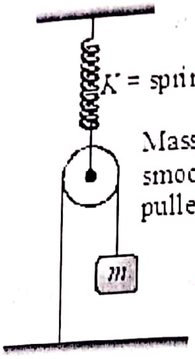
15. A spring (spring constant = k) is cut into 4 equal parts and two parts are connected in parallel. What is the effective spring constant?
a) 4k
b) 16k
c) 8k
d) 6k

Answer: c
Explanation: Spring constant of each one-fourth part = 4k
When two parts are connected in parallel,
$k_p=4k+4k=8k$.

16. The periodic time of a body executing simple harmonic motion is 4s. After how many intervals from time t=0, its displacement will be half of its amplitude?
a) ½ s
b) 1/3 s
c) ¼ s
d) 1/6 s

Answer: b
Explanation: t=1t/12=4/12=1/3 s.

17. The angular frequency of small oscillations of the system shown in the figure is


K = spring constant
Massless smooth pulley
m

(A) $\sqrt{\frac{K}{2m}}$

(B) $\sqrt{\frac{2K}{m}}$

(C) $\sqrt{\frac{K}{4m}}$

(D) $\sqrt{\frac{4K}{m}}$

ANS: C

18. A particle executes SHM with a frequency f. The frequency with which it's KE oscillates is

(A) f/2

(B) f

(C) 2f

(D) 4f

ANS: C

19. A simple pendulum has some time period T. What will be the percentage change in its time period if its amplitudes is decreased by 5 % ?

(A) 6 %

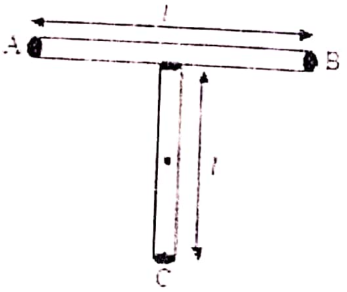
(B) 3 %

(C) 1.5 %

(D) 0 %

ANS: D

20. Two uniform rods are welded together to form a letter T as shown in the figure.



Each rod is of mass M and length ' l ' . If this combination is hinged at ' A ' and kept in vertical plane then time period of small oscillations about A is equal to

(A) $2\pi\sqrt{\frac{l}{6\sqrt{3}g}}$

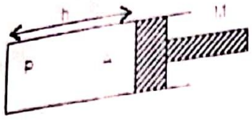
(B) $2\pi\sqrt{\frac{3l}{2\sqrt{2}g}}$

(C) $2\pi\sqrt{\frac{l}{2g}}$

(D) $2\pi\sqrt{\frac{11l}{6\sqrt{5}g}}$

ANS: D

20. A cylindrical piston of mass M slides smoothly inside a long cylinder closed at one end, enclosing a certain mass of a gas.



The cylinder is kept with its axis horizontal. If the piston is slightly compressed isothermally from its equilibrium position, it oscillates simple harmonically, the period of oscillation will be

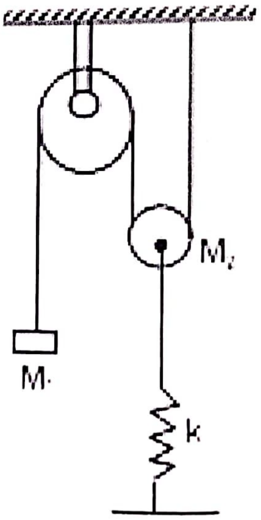
(A) $2\pi\sqrt{\frac{Mh}{PA}}$

(B) $2\pi\sqrt{\frac{MA}{Ph}}$

(C) $2\pi\sqrt{\frac{M}{PAh}}$

(D) $2\pi\sqrt{MPhA}$

21. The period of the free oscillations of the system shown here if mass M_1 is pulled down a little and force constant of the spring is k and masses of the fixed pulleys are negligible, is



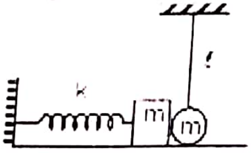
(A) $2\pi\sqrt{\frac{M_1 + M_2}{k}}$

(B) $2\pi\sqrt{\frac{M_1 + 4M_2}{k}}$

(C) $2\pi\sqrt{\frac{M_2 + 4M_1}{k}}$

(D) $2\pi\sqrt{\frac{M_2 + 3M_1}{k}}$

22. A pendulum makes perfectly elastic collision with block of m lying on a frictionless surface attached to a spring of force constant k. Pendulum is slightly displaced and released. Time period of oscillation of the system is



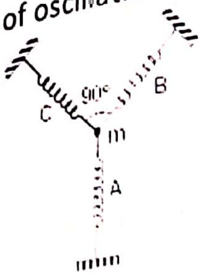
(A) $2\pi\left[\sqrt{\frac{l}{g}} + \sqrt{\frac{m}{k}}\right]$

(B) $\pi\left[\sqrt{\frac{l}{g}} + \sqrt{\frac{m}{k}}\right]$

(C) $2\pi\sqrt{\frac{l}{g}}$

(D) $2\pi\sqrt{\frac{m}{k}}$

23. Three springs of each force constant k are connected as shown figure. Point mass m is slightly displaced to compress A and released. Time period of oscillation



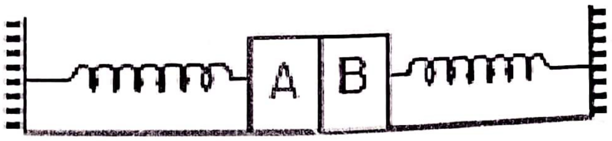
(A) $2\pi\sqrt{\frac{m}{2k}}$

(B) $2\pi\sqrt{\frac{m}{3k}}$

(C) $2\pi\sqrt{\frac{m}{k}}$

(D) $2\pi\sqrt{\frac{m}{k+\sqrt{2}(k+1)}}$

24. Two blocks each of mass m are connected with springs of force constant k. Initially springs are relaxed. Mass A is displaced to left and B is displaced towards right by same amount and released then time period of oscillation of any one block (Assume collision to be perfectly elastic)



(A) $2\pi\sqrt{\frac{m}{k}}$

(B) $2\pi\sqrt{\frac{m}{2k}}$

(C) $\pi\sqrt{\frac{m}{k}}$

(B) $\pi\sqrt{\frac{m}{2k}}$

26. If for a particle moving in SHM, there is a sudden increase of 1% in restoring force just as particle passing through mean position, percentage change in amplitude will be

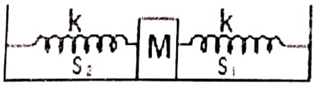
(A) 1%

(B) 2%

(C) 0.5%

(D) zero.

27. S_1 and S_2 are two identical springs. The oscillation frequency is f. If one spring is removed, frequency will be



(A) f

(B) 2f

(C) √2 f

(D) f /√2

28. Energy can be transferred from one place to another through

A. linear motion
B. circular motion
C. force
D. waves

ANS: D

29. When waves moving in one medium fall on the surface of another medium they bounce back into the first medium such that the angle of incidence is equal to the angle of reflection. This phenomenon is known as

A. refraction of waves
B. diffraction of waves
C. reflection of waves
D. deflection of waves

ANS: C

30. The time period of simple pendulum 1 m long at a location where $g=10ms^{-1}$ will be

A. 2.5 s
B. 1.5 s
C. 3 s
D. 1.99 s

ANS: D

31. If 100 waves pass through a medium in 20seconds and their wavelength is 6cm then the velocity is

A. $0.5ms^{-1}$
B. $0.3ms^{-1}$
C. $1ms^{-1}$
D. $2.5ms^{-1}$

ANS: B

32. In a simple pendulum, the force acting along the string is

A. 0
B. mg $\sin\theta$
C. mg $\cos\theta$
D. 1

ANS: A

33. If potential energies and kinetic energies are equal then displacement of an object in SHM is

A. 4
B. 0
C. 2
D. 6

ANS: B

34. If the time period of a simple pendulum is 2 s then it's length is

A. 1.02m
B. 1.2m
C. 1.4m
D. 1.5m

ANS: A

35. The categories of waves are

A. 3
B. 4
C. 2
D. 5

ANS: C

36. If speed is 180 ms^{-1} and frequency is 200 Hz, The wavelength should be

A. 0.9 m
B. 0.5 m
C. 1.2 m
D. 2 m

ANS: A

37. If a simple pendulum is 1.0 m long and force of gravity acting on it is 10.0 ms^{-2}, then it's time period and frequency are

A. 1.99s and 0.50Hz
B. 2s and 60Hz
C. 5s and 40Hz
D. 4s and 60Hz

ANS: A

38. A human ear can oscillate back and forth up to

A. 18,000 times per second
B. 200 times per second
C. 20,000 times per second
D. 100 times per second
ANS: C

39. A pendulum of length 0.65 m is taken to the moon. The period is 5.2 s. The value of "g" on the surface of the moon is

A. 1.5 ms^{-2}
B. 0.948 ms^{-2}
C. 0.35 ms^{-2}
D. 2.35 ms^{-2}
ANS: B

40. If the mass of bob is increased 3 times then it's period

A. increases
B. decreases 2 times
C. remains same
D. increases 4 times
ANS: C

41. If 160 waves pass through a point of a medium in 40 seconds. Its frequency is

A. 4 Hz
B. 2 Hz
C. 5 Hz
D. 3 Hz
ANS: A

42. A transverse wave produced on a spring has a frequency of 200 Hz and travels along the length of a spring of 80 m in 0.5 seconds. The speed of the wave will be

A. 122 ms^{-1}
B. 140 ms^{-1}
C. 133 ms^{-1}
D. 150 ms^{-1}
ANS: C

43. Christian Huygens invented the pendulum clock in

A. 1657
B. 1670
C. 1682
D. 1656

ANS: D

44. At one end of a ripple tank 90 cm across, a 6Hz vibrator produces waves whose wavelength is 30 mm. The time needed to cross the waves is

A. 3 seconds
B. 7 seconds
C. 10 seconds
D. 5 seconds

ANS: D

45. Quantum Numbers are solutions of _____________

a) Heisenberg's Uncertainty Principle
b) Einstein's mass energy relation
c) Schrodinger's Wave Equation
d) Hamiltonian Operator

Answer: c

Explanation: When the wave function for an atom is solved using the Schrodinger Wave Equation, the solutions obtained are called the Quantum Number which are basically n, l and m.

46. Which quantum numbers gives the shell to which the electron belongs?

a) n
b) l
c) m
d) s

Answer: a

Explanation: The principal quantum number, n, gives the shell to which the electron belongs. The energy of the shell is dependent on 'n'.

47. What is the maximum number of electrons in a shell?

a) n
b) 2n
c) n^2
d) $2n^2$

Answer: d

Explanation: The total number of electrons in a shell are given by: $2n^2$ while the number of orbitals present in a shell is given by n^2, which is half the total number of electrons in that shell.

48. Which of the following quantum number gives the shape of atomic orbital of sub-shell?

a) n
b) l
c) m
d) s

Answer: b

Explanation: The Azimuthal quantum number, l, helps in determining the shape of the atomic orbital of sub-shell. It also gives the sub-shell to which the electron belongs.

49. What is the range of Azimuthal Quantum Number, l?

a) 0 to n
b) 0 to s
c) 0 to n-1
d) 0 to s-1

50. The total value of the magnetic quantum number are ______________

a) 2n
b) 2l
c) 2n + 1
d) 2l + 1

Answer: d

Explanation: The magnetic quantum number denotes the orientation of electrons in an atom. The total values of m_e are 2l + 1. They vary from –l to +l.

51. How many values does the spin quantum number have?

a) 2

b) 2l

c) 2n

d) $2m_e$

Answer: a

Explanation: The spin quantum number have only two values: +1/2 and -1/2. It is not a solution of the Schrodinger wave equation.

52. Which of the following can be the quantum numbers for an orbital?

a) n = 4, l = 4, m = 3

b) n = 2, l = 3, m = 1

c) n = 3, l = 2, m = -1

d) n = 3, l = 0, m = -3

Answer: c

Explanation: In the given options, option c is the correct option because in this the value of l is between 0 – n-1 and value of m is between –l to +l.

53. An electron makes a transition from n = 5 state to n = 2 state in the hydrogen atom. What is the frequency of the emitted photon?

a) 4.9×10^{14} Hz

b) 5.9×10^{14} Hz

c) 6.9×10^{14} Hz

d) 7.9×10^{14} Hz

ANS: C

54. The subshell dz^2 has no nodal plane.

a) True

b) False

Answer: a

Explanation: The subshell dz^2 has a ring in x-y plane and is based on the z-plane. Thus the probability of finding an electron is never zero for this sub-shell.

55. Nodes are the plane where the probability of finding an electron is 1.

a) True

b) False

Answer: b

Explanation: Nodal planes are described as the planes where the probability of finding an electron is not equal to zero. The total number of nodes in an orbital is n -1.

56. The probability of finding an electron is uniform in every direction is in which orbital?

a) s

b) p

c) d

d) p

Answer: a

Explanation: For an s-orbital, the probability of finding an electron is uniform in every direction. For p orbitals, the probability of finding an electron is along one direction only.

57. A child sits stationary at one end of a long trolley moving uniformly with speed v on a smooth horizontal floor. If the child gets up and runs about on the trolley in any manner, then what is the effect of the speed of the centre of mass of the (trolley+child) system?

a) The speed of the centre of mass increases

b) The speed of the centre of mass decreases

c) The speed of the centre of mass will not change

d) The speed of the centre of mass will first increase and then decrease

Answer: c

Explanation: The force involved in the given problem is the internal forces of the system. No external force acts on the system when the child runs So, there will be no change in the speed of the centre of mass of the (trolley+child) system.

58. **A solid sphere rolls down two different inclined planes of the same heights but different angles of inclination. In each case, the ball will reach the bottom ____________**

a) With the same speed
b) With different speed
c) With different speed but same time
d) Immediately

Answer: a

Explanation: Acceleration of the rolling sphere,
$a=g\sin\theta/((1+k^2/R^2))$
Velocity of the sphere at the bottom of the inclined plane,
$v=\sqrt{(2gh/((1+k^2/R^2)))}$
The sphere will reach the bottom with the same speed v because h is the same in both the cases.

59. A solid sphere rolls down two different inclined planes of the same heights but different angles of inclination. In each case, the ball will ____________

a) Reach the bottom at the same time
b) Will take longer time to roll down one plane
c) Reach the bottom at an unpredictable time
d) Reach the bottom at the same time and keeps rolling

Answer: b

Explanation: Acceleration of the rolling sphere,
$a=g\sin\theta/((1+k^2/R^2))$
Velocity of the sphere at the bottom of the inclined plane,
$v=\sqrt{(2gh/((1+k^2/R^2)))}$
The sphere will take a longer time to roll down one plane than the other. It will take a larger time in case if the plane with smaller inclination because the acceleration is proportional to sinθ.

60. A hook of radius 2m weighs 100kg. It rolls along a horizontal floor so that its centre if mass has a speed of 20cm/s. How much work has to be done to stop it?

a) 5 J
b) 6 J
c) 2 J
d) 4 J

Answer: d

61. During rolling, the force of friction acts in the same direction as the direction of motion of the centre of mass of the body.

a) True

b) False

Answer: a

Explanation: When a body rolls, the force if the friction acts in the same direction as the direction of motion of the centre of mass of the body.

62. Where does the centre of mass of two particles of an equal mass lie?

a) Inside the body

b) Outside the body

c) Near the first body

d) Midway between them

Answer: d

Explanation: The centre of mass of two particles of equal masses lies midway between them. Its position vector is the average of the position vectors of the two particles.

63. Two particles A and B, initially at rest, move towards each other under mutual force of attraction. At the instant when the speed of A is v and the speed of B is 2v, what is the speed of mass of the system?

a) 3v

b) v

c) Zero

d) 1.5v

Answer: c

Explanation: No external force is acting on the centre of mass. It remains at rest. The speed of centre of mass is zero.

64. A smooth sphere A is moving on a frictionless horizontal plane with angular speed ω and the centre of mass velocity u. It collides elastically and head on with an identical sphere B at rest. Neglect friction everywhere. After the collision, their angular speeds are $\omega_{(A)}$ and $\omega_{(B)}$ respectively. Then?

a) ω_A is lesser than ω_B

b) $\omega_A=\omega_B$

c) $\omega_A=\omega$

d) $\omega_B=\omega$

Answer: c

Explanation: Only their linear velocities are exchanged. The two spheres cannot exert torques on each other, as their surfaces are frictionless, and so that angular velocities of the sphere do not change.

65. Moment of inertia of a circular wire of mass M and radius R about its diameter is ____________

a) 1/2 MR^2

b) 1/4 MR^2

c) $2MR^2$

d) MR^2

Answer: b

Explanation: A circular wire behaves like a ring. By perpendicular axes theorem,

$I_D+I_D=1/2\ MR^2$

Therefore,

1/4 MR^2.

66. One solid sphere ‘A’ and another hollow sphere ‘B’ are of same mass and same outer radii. Their moments of inertia about their diameters are respectively I_A and I_B, such that ____________

a) $I_A=I_B$

b) I_A is greater thab I_B

c) I_A is lesser than I_B

d) $I_A/I_B = \rho_A/\rho_B$

Answer: c

Explanation: In a hollow sphere, the mass is distributed away from the axis of rotation. So, its moment of inertia is greater than that of a solid sphere.

67.The number of forces that can be added by head to tail rule are

A. 4

B. 2

C. 5

D. any number

ANS: D

68. If the distance between all pairs of particles of the body do not change by applying a force then the body is said to be

A. flexible
B. small
C. large
D. rigid

ANS: D

69. Consider a 4-fold degenerate state with orthonormal eigenfunctions 1 2 3 4 u u u u , , and . There is a perturbation H . It is given that 12 21 H H g g; 0 and all the other matrix elements are zero. Find the splitting and corresponding wavefunctions.

(a) g g , ,0,0
(b) 2 , ,0,0 g g
(c) g g, ,0,0
(d) g,0,0,0

ANS: A

70. Due to perturbation of the orbit, satellite orbit parameters are frequently updated on measurements carried out by its__________________?

A. Six ground stations
B. Five ground stations
C. Four ground stations
D. Three ground stations

ANS: B

71. Due to scan geometry of a satellite sensor__________________?

A. The off-nadir resolution is degraded
B. The ground distance swept by the senor, IFOV is proportional to sec2 of scan measured from the nadir
C. The details towards the edge of the scan get compressed
D. All of these

ANS: D

ATOMIC PHYSICS

[Rutherford and Bohr models, Atomic Energy levels and Atomic Spectra, Black-body Radiation, X-rays]

1. In the wave-mechanical model of an atom, degenerate energy levels have:

a) Equal energy
b) Equal number of electrons
c) Same shape
d) Electrons with the same spin

Answer: a

Explanation: Degenerate energy levels have equal energy. In an atom, the orbitals in the same subshell are degenerate in absence of an external magnetic field.

2. Paired electrons in an atom have equal values of all of the four quantum numbers.

a) True
b) False

Answer: b

Explanation: According to Pauli's exclusion principle, no two electrons in an atom can have all four quantum numbers equal. Paired electrons have opposite spins.

3. Protons attract electrons. Then why do electrons not fall on the nucleus?

a) Neutrons repel the electrons
b) Electrons in ground state cannot radiate energy
c) At very small distances, protons repel electrons
d) Inner electrons repel those in outer orbitals

Answer: b

Explanation: In the ground state, electrons form standing waves. Standing waves are those in which energy is not transferred. Hence, electrons are bound to revolve around the nucleus with constant potential energy.

4. Number of atomic orbitals in nth shell is:

a) n^2
b) $2n^2$
c) $2n + 1$
d) $n - 1$

Answer: a

Explanation: Every shell contains n^2 orbitals and every orbital can accommodate a maximum of 2 electrons. Hence a maximum of $2n^2$ electrons can reside in nth shell.

5. Electronic configuration of Cu is [Ar] 3d10 4s1. Which rule is violated in this configuration?
   a) Aufbau Principle
   b) Hund's Rule of Maximum Multiplicity
   c) Pauli's Exclusion Principle
   d) None of the mentioned

Answer: a

Explanation: According to the Aufbau principle, orbitals of lower energy are completely filled before electrons start occupying higher energy orbitals. But in copper, higher energy 3d is filled before lower energy 4s. Such violation of the Aufbau principle appears in about 20 elements.

6. When an electron shifts to an inner shell, it:
   a) Absorbs photon
   b) Emits a photon
   c) Emits a positron
   d) Absorbs a positron

Answer: b

Explanation: Generally, lower potential energy means more stability. Excited electrons lose energy in the form of photons to shift to stable empty inner shells. Positron is anti-particle of an electron.

7. Around 1911, Rutherford suggested a planetary model of atomic structure. Which of the following was not a proposition of this model?
   a) Electrons revolve in circular orbits around the nucleus
   b) Nucleus consists of protons and neutrons
   c) Mass of atom is concentrated in the nucleus
   d) Most of the volume in an atom is void

Answer: b

Explanation: Neutrons were not discovered by then. Rutherford only suggested that the nucleus has a positive charge, but did not comment on its structure.

8. Which of the Bohr's postulates was incorrect?
   a) Energy of electrons is quantized
   b) Momentum of electrons is quantized
   c) Electrons release energy when shifting from excited state to ground state
   d) Electrons revolve around the nucleus in fixed circular orbits

Answer: d

Explanation: Heisenberg uncertainty principle implies that exact position and momentum of electrons cannot be known with certainty and hence, definite circular paths are not feasible. Certain regions around the nucleus (called orbitals) have a high probability of the existence of electrons.

9. 4f orbital has higher energy than 5p.
   a) True
   b) False

Answer: a

Explanation: Sum of principal and azimuthal quantum numbers for 4f is (4+3=) 7 and that for 5p is (5+1=) 6. As a general rule, higher the sum, higher is the energy.

10. Which of the following orbitals do not exist?
   a) 3p
   b) 4s
   c) 2s
   d) 3f

Answer: d

Explanation: For principal quantum number 3, only possible values of azimuthal quantum number are 0, 1, and 2. Azimuthal quantum number of an f-orbital is 3.

11. Which source is associated with a line emission spectrum?
   a) Electric fire
   b) Neon street sign
   c) Red traffic light
   d) Sun

Answer: b

Explanation: Neon street sign gives a line emission spectrum. When neon atoms gain enough energy to become excited, light is produced. Atom releases a photon when it returns to a lower energy state. Therefore, the source associated with a line emission spectrum is the neon street sign.

12. According to the uncertainty principle for an electron, time measurement will become uncertain if which of the following is measured with high certainty?

a) Energy

b) Momentum

c) Location

d) Velocity

Answer: a

Explanation: According to the uncertainty principle,

$\Delta E.\Delta t >= h/2\pi$.

Thus the time measured will become uncertain if ΔE is measured with high certainty.

13. Find the true statement.

a) An electron will not lose energy when jumping from the 1st orbit to the 3rd orbit

b) An electron will not give energy when jumping from the 1st orbit to the 3rd orbit

c) An electron will release energy when jumping from the 1st orbit to the 3rd orbit

d) An electron will absorb energy when jumping from the 1st orbit to the 3rd orbit

Answer: d

Explanation: An electron will absorb energy when jumping from the 1st orbit to the 3rd orbit. Only by absorbing energy, an electron will be able to jump from the first orbit to the third orbit in the atomic spectrum.

14. **The size of the atom is proportional to which of the following?**

a) **A**
b) $A^{1/3}$
c) $A^{2/3}$
d) $A^{1/3}$

Answer: b

Explanation: The size of the atom is proportional to $A^{1/3}$. The electron affinity of the atom is inversely proportional to the atomic size. As the number of energy levels increases, the atomic size must increase.

15. The Bohr model of atoms uses Einstein's photoelectric equation.

a) True
b) False

Answer: b

Explanation: Bohr model assumes that the angular momentum of electrons is quantized. Therefore, the Bohr model of the atoms involved is independent of Einstein's photoelectric equation.

16. What is the ratio of minimum to maximum wavelength in the Balmer series?

a) 5:9
b) 5:36
c) 1:4
d) 3:4

Answer: a

Explanation: For a wavelength of Balmer series,

$$\frac{1}{\lambda} = R\left[\frac{1}{4} - \frac{1}{9}\right]$$

$$\frac{1}{\lambda} = \frac{5R}{36}$$

$$\frac{\lambda_{min}}{\lambda_{max}} = \frac{5R}{36} \times \frac{4}{R}$$

$$\frac{\lambda_{min}}{\lambda_{max}} = \frac{5}{9}$$

17. The energy of characteristic X-ray is a consequence of which of the following?

a) The energy of the projectile electron
b) The thermal energy of the target
c) Transition in target atoms
d) Temperature

Answer: c

Explanation: The energy of characteristic X-ray is a consequence of transition in target atoms. They cause emission or absorption of electromagnetic radiation. The other options are not responsible for the energy of characteristic X rays.

18. Find out the minimum energy required to take out the only one electron from the ground state of Li$^+$?

a) 13.6 eV
b) 122.4 eV
c) 25.3 eV
d) 67.9 eV

Answer: b

Explanation: Ionization energy is given as:

$E = 13.6 Z^2$ eV
For Li$^+$, $Z = 3$
$E = 13.6 \times 9$
$E = 122.4$ eV

19. What is the energy required to ionize an H-atom from the third excited state, if ground state ionization energy of H-atom is 13.6 eV?

a) 1.5 eV
b) 3.4 eV
c) 13.6 eV
d) 12.1 eV

Answer: a

Explanation: From third excited state, $E = -13.6/.16$
$E = -0.85$ eV
Energy required to ionize H-atom from second excited state = $0 - (-0.85)$
$E = +0.85$ eV

20. As the wavelength of the radiation decreases, the intensity of the black body radiations ____________

a) Increases
b) Decreases
c) First increases then decrease
d) First decreases then increase

Answer: c

Explanation: In the case of Black Body radiations, as the body gets hotter the wavelength of the emitted radiation decreases. However, the intensity first increases up to a specific wavelength than starts decreasing, as the wavelength continues to decrease.

21. The radiations emitted by hot bodies are called as ________

a) X-rays
b) Black-body radiation
c) Gamma radiations
d) Visible light

Answer: b

Explanation: The phenomenon of black—body radiations was given by Max Planck. He stated that hot bodies emit radiation over a wide range of wavelengths. An ideal body is the one that emits and absorbs radiation of all frequencies. Such a body called a Black Body and the radiations are called Black body radiations.

22. An iron rod is heated. The colors at different temperatures are noted. Which of the following colors shows that the iron rod is at the lowest temperature?

a) Red
b) Orange
c) White
d) Blue

Answer: a

Explanation: As the body gets hotter, the frequency of the emitted radiation keeps on increasing. Blue color has the highest frequency out of red, orange and white. Thus, as the iron rod gets heated first it would become red, then orange, then white and then finally blue.

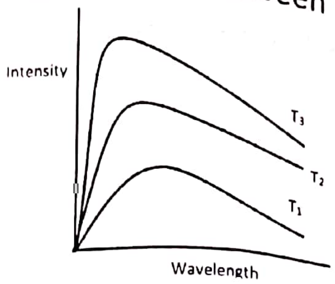
23. A black body is defined as a perfect absorber of radiations. It may or may not be a perfect emitter of radiations.

a) True
b) False

Answer: b

Explanation: A black body is defined as the one which is a perfect absorber as well as a perfect emitter of radiations. Such a body would absorb all the radiations falling on it and would emit all of them when heated.

24. From the figure, what's the relation between T_1, T_2, and T_3?



a) $T_1 > T_2 > T_3$

b) $T_3 > T_2 > T_2$

c) $T_3 > T_1 > T_2$

Answer: b

Explanation: We already know, as the temperature of the body is higher, the intensity of the black body radiations would be higher. Thus, from the graph, the radiations with temperature T_3 has the highest intensity followed by the one with temperature T_2 and then T_1. Thus, $T_3 > T_2 > T_1$.

25. Electromagnetic wave theory of light could not explain Black Body radiations.

a) True

b) False

Answer: a

Explanation: According to electromagnetic theory, the absorption and the emission should be continuous. As the wavelength keeps decreasing, the intensity of the emitted radiations should keep increasing to infinity. Such is not the case with Black Body Radiations.

26. The unit of absorptive power is ________________

a) T

b) Ts^{-1}

c) Ts

d) No unit

Answer: d

Explanation: Absorptive power can be defined as the ratio of energy absorbed per unit area upon energy incident per unit time per unit area. For a black body, it's absorptive power is equal to one.

27. For an object other than a black body, it's emissivity, e is

a) 1
b) $0 < e < 1$
c) $e > 1$
d) $e = 0$

Answer: b

Explanation: Emissivity is the ratio of emissive power of any object and the emissive power of the black body having the same temperature and surface area as the object. Thus, for a black body, it is equal to 1. For any other object, it is less than 1.

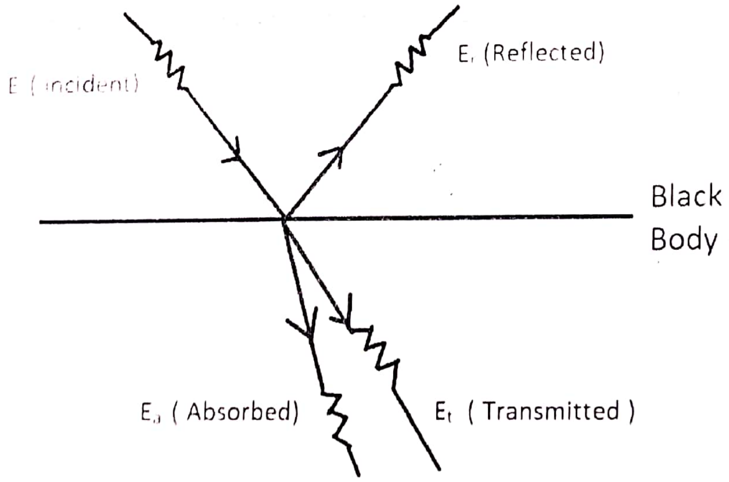
28. What relation between emissivity, e, and Absorptive Power, a, is given by Kirchhoff's law?

a) $e < a$
b) $e > a$
c) $e = a$
d) no specific relation

Answer: c

Explanation: Kirchhoff's law states that for any object the emissivity is always equal to absorptive power. For a black body, both of them are equal to one.

29. What is the relation between the Energies as shown in the figure?



a) $E_r = 0$
b) $E_a = 0$
c) $E_t = E_i$
d) $E_i = E_r$

Answer: a
Explanation: As a black body is a perfect absorber, the reflected energy and the transmitted energy should be zero. Also, the energy of the incident radiation should be equal to the energy absorbed.

30. Alpha (α) particles are helium (He) nucleus with a charge of

A. e
B. 2e
C. 3e
D. 4e

ANS: B

31. When two light nuclei combine to form a heavier nucleus, the process is said to be

A. nuclear fission
B. nuclear fusion
C. nuclear power
D. nuclear transmutation

ANS: B

32. If a C-14 has a half-life of 5730 years, then how long will it take for the number of C-14 in a sample to drop to 1/8 of initial quantity?

A. 2.58×10^4 years
B. 1.44×10^4 years
C. 1.72×10^4 years
D. 2.58×10^4 years

ANS: C

33. In SI base units, 1 Bq is equal to

A. 10 disintegration per second
B. 1.5 disintegration per second
C. 0.01 disintegration per second
D. 1 disintegration per second
ANS: D

34. The radiation emitted from the splits into

A. 2 components
B. 4 components
C. 5 components
D. 3 components
ANS: D

35. Nuclei with atomic number 1 to 82 are

A. stable
B. unstable
C. moderately stable
D. radioactive
ANS: A

36. The elements whose atomic number is greater than 82 are naturally

A. unstable nuclei
B. stable nuclei
C. positive nuclei
D. negative nuclei
ANS: A

37. The age of fossil when C-14: C-12 in bone is one fourth of ratio in bone of living animal and half-life of C-14 is 5732 years is

A. 100 years
B. 11460 years
C. 1000 years
D. 1200 years
ANS: B

38. If a radioactive element has a half-life of 40 minutes. The initial count rate was 1000 per minute, then how long will it take for the count rate to drop to 125 per minutes

A. 120 minutes
B. 90 minutes
C. 30 minutes
D. 60 minutes
ANS: A

39. The fast-moving light photons are

A. alpha radiation
B. gamma radiation
C. beta radiations
D. no radiations
ANS: B

40. In nuclear fission, as compared to the original mass of the heavy nucleus, the total mass of the product is

A. equal
B. more
C. less
D. zero
ANS: C

41. If the activity of a sample of radioactive bismuth decreases to 1/8 of its original activity in 15 days, then the sample's half-life will be

A. 3 days
B. 10 days
C. 5 days
D. 7 days
ANS: C

42. Technimum-99 has a half-life of 6 hours. If there is 300 mg of it, how much will be left in 48 hours?

A. 1.58 mg
B. 1.25 mg
C. 1.17 mg
D. 2.56 mg
ANS: C

43. In the atmosphere, a small amount is present of radioactive

A. carbon-15
B. carbon-19
C. carbon-10
D. carbon-14
ANS: D

44. The temperature at the center of the Sun is nearly

A. 20 million Kelvin
B. 10 million Kelvin
C. 30 million Kelvin
D. 25 million Kelvin

ANS: A

45. When alpha and beta particles are slowed down by collisions, they become

A. harmful
B. harmless
C. useful
D. expensive
ANS: B

46. The half-life of carbon-14 is

A. 1359 years
B. 4860 years
C. 5730 years
D. 2890 years
ANS: C

47. The half-life of a radioactive element is 10 minutes. If the initial count rate is 368 counts per minute, then the time for which count rate reaches 46 counts per minute would be?

A. 30 minutes
B. 40 minutes
C. 15 minutes
D. 23 minutes
ANS: A

48. Per year safe limit of radiation exposure is

A. 5 rem
B. 10 rem
C. 7 rem
D. 15 rem
ANS: A

49. The safe level of radiation exposure per year is

A. 1.0 rem
B. 2.0 rem
C. 5.0 rem
D. 4.0 rem
ANS: C

50. The activity of 1 gram of radium is

A. 3.73×10^4 MBq
B. 4.58×10^4 MBq
C. 1.69×10^4 MBq
D. 2.56×10^4 MBq
ANS: A

51. The number of protons in the nucleus is called

A. neutron number (N)
B. atomic number (Z)
C. atomic mass number (A)
D. electron number (E)
ANS: A

52. The lifetime of unstable nuclei is

A. limited
B. unlimited
C. 100 years
D. 50 years
ANS: B

53. The word atom is derived from the Greek word

A. antimum
B. atomis
C. otomos
D. optium
ANS: C

54. It is given for the azimuthal quantum number l = 3, the total number of different possible values of the magnetic azimuthal quantum number, m_l is.

a) 3
b) 7
c) 4
d) 5
ANS: B

55. Number of electrons that constitute one ampere of current is :

a) 265×10^{16}
b) 625×10^{12}
c) 4.8×10^{10}
d) 625×10^{16}
ANS: B

56. If Bohr's radius is R_0 then radius of 3rd orbit of 143ydrogen atom will be:

a) $3R_0$
b) $6R_0$
c) $9R_0$
d) $12R_0$
ANS: B

57. In the lowest orbit, the binding energy of an electron in hydrogen atom is 13.6 eV. The energy required to take out the electron from the lower three orbits in (eV) will be:

a) 13.6, 6.8, 8.4
b) 13.6, 10.2, 3.4
c) 13.6, 27.2, 40.8
d) 13.6, 3.4, 1.5
ANS: D

58. Minimum excitation potential of Bohr's first orbit in hydrogen atom is:

a) 13.6 V
b) 3.4 V
c) 10,2 V

ANS: C

59. α-particles are projected towards the nuclei of the following metals, with the same kinetic energy. Towards, which metal, the distance of closest approach is minimum ?

a) Cu (Z = 29)
b) Ag (Z = 47)
c) Au (Z = 79)
d) Pd (Z = 46)

ANS: A

60. An α-particle accelerated through V volt is fired towards a nucleus. Its distance of closest approach is r. If a proton accelerated through the same potential is fired towards the same nucleus, the distance of closest approach of proton will be :

a) r
b) 2r
c) r/2
d) r/4

ANS: A

61. The distance of closest approach of an α-particle fired towards a nucleus with momentum p, is r. What will be the distance of closest approach when the momentum of a-particle is 2p ?

a) 2r
b) 4r
c) r/2
d) r/4

ANS: D

62. Which of the following is incorrect regarding Rutherford's atomic model ?

a) Atom contains nucleus
b) Size of nucleus is very small in comparison to that of atom
c) Nucleus contains about 90% mass of the atom
d) Electrons revolve round the nucleus with uniform speed

ANS: C

63. In Rutherford experiment the number of a-particles scattered through an angle 60° is 112 per minute, then the number of α particles scattered through an angle of 90° per minute by the same nucleus is :

a) 28 per min
b) 112 per min
c) 12.5 per min
d) 7 per min

ANS: A

64. ____ is defined as number of waves per unit length.

(A) Rydberg's number

(B) Bohr number

(C) Wave number

(D) Radiation number

ANS: C

SPECIAL TOPICS

[Nuclear & Particle Physics, Condensed Matter Physics, Mathematical Methods in Physics, Computational Physics, Special Relativity, Laboratory Methods]

1. Nuclear fission is the phenomenon of ______________

a) Heavy nucleus splitting
b) Heavy nucleus combining
c) Light nucleus splitting
d) Light nucleus combining

Answer: a

Explanation: Nuclear fission is the phenomenon of splitting of a heavy nucleus into lighter nuclei. The nucleus generally has a mass number greater than 230.

2. The Q-value of fission reaction is of the order ______________

a) 10 MeV
b) 100 MeV
c) 200 MeV
d) 500 MeV

Answer: c

Explanation: The Q-value of a reaction is the energy released in a fission reaction. It is of the order 200MeV per fissioning nucleus.

3. An atom bomb is a ______________

a) Controlled fission reaction
b) Controlled fusion reaction
c) Uncontrolled fission reaction
d) Uncontrolled fusion reaction

Answer: c

Explanation: A chain reaction is a series of fission reactions. In an atom bomb, an uncontrolled chain reaction proceeds while in a nuclear reactor a controlled chain reaction is produced.

4. The average energy of a neutron produced in a fission of Uranium 235 isotope is ______________

a) 1 MeV
b) 2 MeV
c) 10 MeV
d) 100 MeV

Answer: b

Explanation: The average energy of a neutron produced in fission of a uranium 235 isotope is 2 MeV. These neutrons unless slowed down will escape from the reactor without interacting with uranium nuclei.

5. The moderator commonly used is ________
   a) Diamond
   b) Graphite
   c) Lead
   d) Copper

Answer: b

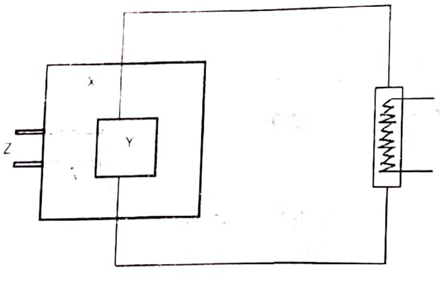
Explanation: The most commonly used moderators are water, heavy water and graphite. Moderators are used to control the chain-reaction and slow down the neutrons

6. The neutrons slowed down by moderators are called as ________
   a) Slowed neutrons
   b) Thermal neutrons
   c) Fission neutrons
   d) Moderated neutrons

Answer: b

Explanation: The neutrons which are slowed down by the moderators are referred to as thermal neutrons. The neutron slow down after colliding with the moderators, which are made up of water, heavy water etc.

7. Following is the diagram of a nuclear reactor. Identify X.



   a) Control Rods
   b) Core
   c) Reflectors
   d) Coolant

Answer: c

Explanation: In the given figure, X is the reflectors, which helps in reducing the leakage, z are the control rods, present for safety, and Y is the core, where the nuclear fission reaction takes place.

8. How many fission takes place per second in a 300 MW reactor, assuming each fission releases 200 MeV of energy?
   - a) 2.38×10^{18}
   - b) 4.38×10^{18}
   - c) 8.38×10^{18}
   - d) 9.38×10^{18}

Answer: d

Explanation: Let n bet the number of fissions.

Energy released per second = $200 \times 10^{6} \times 1.6 \times 10^{-19} \times n$ J

= $n \times 3.2 \times 10^{-11}$ J

Power = Energy/Time

$300 \times 10^{6} = n \times 3.2 \times 10^{-11}$

$n = 9.38 \times 10^{18}$.

9. The fission of a single nucleus of ^{235}U releases 200 MeV of energy. What is the number of fissions that must occur to produce a power of 1 MW?
   - a) 3.23×10^{16}
   - b) 3.12×10^{16}
   - c) 4.38×10^{16}
   - d) 5.38×10^{16}

Answer: b

Explanation: Energy released per second = n X 200 MeV

= $n \times 200 \times 1.6 \times 10^{-19}$ J

Energy produced per second = Power X time

= 1 MW X 1s

$n \times 200 \times 1.6 \times 10^{-19}$ J = 10^{6} J

$n = 3.12 \times 10^{16}$.

10. Calculate the energy released by the fission of 5 gm of ^{235}U in kWh if energy released per fission is 200 MeV.

a) 1.13 X 10^5 kWh
b) 2.65 X 10^5 kWh
c) 3.78 X 10^5 kWh
d) 4.12 X 10^5 kWh

Answer: a

Explanation: Now, Number of atoms in 5 g of $^{235}U = 6.023 \times 10^{23} \times 5/235$
Energy released by the fission = $6.023 \times 10^{23} \times 5 \times 200 \times 1.6 \times 10^{-19} / 235$
= 4.1×10^{11}J
1.13 X 10^5 kWh.

11. If the number of fissions are 2.375 X 10^{24}, what is the mass of uranium 235 isotope used?

a) 789.23 g
b) 879.32 g
c) 926.65 g
d) 980.74 g

ANS: C

12. At high temperatures, which material is the best choice to be used as coolant in a nuclear reactor?

a) Water
b) Heavy water
c) Molten Potassium
d) Molten Carbon

Answer: c

Explanation: Water and heavy water are good coolants, but due to their low boiling points, they need pressurization. At high temperature, liquid metals like molten sodium or potassium are excellent coolants.

13. Which of the following is an essential requirement for initiating the fusion reaction?

a) Critical mass
b) Thermal neutrons
c) High temperature
d) Critical temperature

Answer: c

Explanation: Two or more atomic nuclei are combined to form one or more different atomic nuclei and subatomic particles. High temperature is essential for initiating the fusion reaction. The others are not an essential requirement.

14. What amount of energy is released by deuterium and tritium fusion?

a) 60.6 eV
b) 12.6 eV
c) 17.6 eV
d) 28.33 eV

Answer: c

Explanation: ${}_1H^2 + {}_1H^3 \rightarrow {}_2He^4 + {}_0n^1 + Q$.
$= [2.014 + 3.016 - 4.002 - 1.008] \times 931.5$ MeV.
$= 17.6$ MeV.

15. In a nuclear reaction, there is the conservation of which of the following?

a) Mass only
b) Energy only
c) Momentum only
d) Mass, energy, and momentum

Answer: d

Explanation: Two or more atomic nuclei are combined to form one or more different atomic nuclei and subatomic particles. In any nuclear reaction, mass, energy, and momentum are conserved. So, all three are conserved.

16. Solar energy is mainly caused due to fission of uranium present in the sun.

a) True

b) False

Answer: b

Explanation: No, this is a false statement. Solar energy is mainly caused due to the fusion of protons during the synthesis of heavier elements. So, it is not fission, but it is the fusion that results in solar energy.

17. Which of the following is used as a moderator in a nuclear reactor?

a) Cadmium

b) Plutonium

c) Uranium

d) Heavy water

Answer: d

Explanation: Heavy water is used as a moderator in a nuclear reactor. It slows down neutrons and also has a low probability of absorption of neutrons. The other options are not valid.

18. In nuclear reactors, what are the controlling rods made of?

a) Cadmium

b) Graphite

c) Stainless steel

d) Plutonium

Answer: a

Explanation: In nuclear reactors, cadmium rods are used as control rods. They are used to absorb the extra nucleons and to absorb neutrons, making them unavailable to cause fission. The other options are not valid.

19. The operation of a nuclear reactor is said to be critical if the multiplication factor (k) has a value of what?

a) 1

b) 0

c) 1.5

d) 2.1

Answer: a

Explanation: For a nuclear reactor, k = 1. It is the ratio of the number of neutrons produced in a nuclear pile to the number disappearing that must equal to unity for a chain reaction.

20. A neutron can cause fission in which of the following?

a) Hydrogen
b) Uranium-235
c) Thorium
d) Uranium-238

Answer: b

Explanation: A neutron, irrespective of whether it is slow or fast, can cause fission in a Uranium 235 nuclei. It absorbs a neutron and fissions into two new atoms by releasing some binding energy.

21. What is the energy released in a nuclear reaction called?

a) R-value
b) Q value
c) P-value
d) Nuclear energy

Answer: b

Explanation: In a nuclear reaction, the sum of masses before the reaction is greater than the sum of masses after the reaction. The difference in masses appears in the form of energy following the law of inter-conversion of mass and energy. Thus, the energy released in a nuclear reaction is called a Q value of a reaction.

22. When do ionic compounds conduct electricity?

a) In gaseous state
b) In solid state
c) When dissolved in water
d) They never conduct

Answer: c

Explanation: Ionic compounds can conduct electricity only if their ions are free to move. Hence, they behave as conductors when they are dissolved in water.

23. Which of the following covalent compounds conduct electricity?

a) Silica
b) Graphite
c) Diamond
d) Hydrogen chloride

Answer: b

Explanation: Graphite is made up of carbon layer that can slide over each other. Like metals, the electrons are free to move. Whereas, the rest of the compounds are made up of carbon atoms held together tightly. Therefore, graphite is the covalent compound that conducts electricity.

24. What is the possible number of different types of lattices (3D)?

a) 4
b) 8
c) 14
d) 17

Answer: c

Explanation: According to Bravis, there are only 14 possible ways of arranging points in space lattice from the 7 crystal systems such that, all the lattice points have exactly the same surrounding.

25. What is the lattice constant for FCC crystal having atomic radius 1.476 Å?

a) 1.476 Å
b) 4.1748 Å
c) 5.216 Å
d) 0

Answer: b

Explanation: Radius=1.476 Å or 1.476 × 10^{-10} m

Lattice constant for FCC = $4r/\sqrt{2}$

Lattice constant = 4.1748 Å.

26. The interplanar spacing of (220) planes of a FCC structure is 1.7458 Å. Calculate the lattice constant.

a) 4.983 Å

b) 2.458 Å

c) 0

d) 5.125 Å

Answer: a

Explanation:

$D = 1.7458$ Å $= 1.7458 \times 10^{-10}$ m

$h = 2;\ k = 2;\ l = 0$

$D = a/\sqrt{(h^2+k^2+l^2)}$

$a = 4.983$ Å.

27. Which of the following is a vector?

(a) speed

(c) displacement

(b)mass

(d) time

ANS: C

28. A vector is not changed if________________

(a) it is rotated through an arbitrary angle

(b) it is multiplied by an arbitrary scalar

(c) it is cross multiplied by a unit vector

(d) it is slid parallel to itself.

ANS: D

29. Which of the sets given below may represent the magnitudes of three vectors adding to zero?

(a) 2, 4, 8

(b) 4, 8, 16

(c) 1, 2, 1

(d) 0'5, 1, 2.

ANS: C

30. The equation vector a + a = a is______

(a) meaningless

(b) may be possible for unlimited values of a

(c)always true

(d) true only when a =0

ANS: D

31. If A + B = A - B then vector B must be______

(a) zero vector

(b) nonzero vector

(c) unit vector

(d) equal to

ANS: A

32. The resultant of two forces 3N and 4N is 5N , the angle between the forces is______

(a)300

(b) 600

(c) 900

(d) 1200

ANS: C

33. A vector A points vertically upward and B points towards north. The vector product A x B is______

(a) along west

(c) zero

(b) along east

(d) vertically downward.

Answer: A

34. The radius of a circle is stated as 2.12 cm. Its area should be written as

(a) 14 cm^2

(b) 14.1 cm^2

(c) 14.11 cm^2

(d) 14.1124 cm^2

Answer: B

35. What is the maximum number of components into which force can be resolved?

(a)Two

(b) three

(c) Four

(d) Any number

Answer: D

36. The magnitude of scalar product two-unit vectors perpendicular to each other is____________

(a)zero

(b) 1

(c) -1

(d)2

Answer: A

37. A force 16 N acting perpendicular to a force of 80 N, magnitude of resultant force is_________

(a)20N

(b) 70N

(c)100N

(d)140N

Answer: C

38. A situation may be described by using different sets of coordinate axes having different orientations. Which of the following do not depend on the orientation of the axes?

(a) the value of a scalar

(b) a vector

(c) the magnitude of a vector.

(d) All

Answer : D

39. The x-component of the resultant of several vectors ______

(a) Is equal to the sum of the x-components of the vectors

(b) may be smaller than the sum of the magnitudes of the vectors

(c) may be equal to the sum of the magnitudes of the vectors.

(d) All

Answer: D

40. Two forces whose magnitudes are in ratio of 3:5 give a resultant of 35N. If the angle of inclination is 60°, calculate the magnitude of each force.

a) 15N and35N
b) 15N and 25N
c) 10N and 15N
d) 20N and 5N

ANS: B

41. Walking off a man is an example of ______

a) Resolution of forces
b) Addition of vectors
c) Subtraction of vectors
d) Multiplication of vectors

Answer: a

Explanation: While walking, a person presses the ground with his feet slightly slanted in the backward direction. The ground exerts upon him an equal and opposite reaction. Its horizontal component enables the person to move forward while the vertical component balances this weight.

42. Flying a bird is an example of ______________
a) Collinear vector
b) Multiplication of vector
c) Addition of vector
d) Composition of vector

Answer: d

Explanation: When a bird flies, it pushes the air with force in the downward direction with its wings. In accordance with Newton's law of motion, the air exerts equal and opposite reaction. According to the parallelogram law, the resultant of the reaction acts on the birds in the upward direction and helps the bird to fly upwards.

43. Which of the following has zero magnitude?
a) Fixed vector
b) Zero vector
c) Modulus of a vector
d) Unit vector

Answer: b

Explanation: A zero or null vector is a vector that has zero magnitude and an arbitrary direction. The velocity vector of a stationary object is a zero vector.

44. Which of the following acts in accordance with right hand screw rule?
a) Polar vector
b) Axial vector
c) Displacement vector
d) Position vector

Answer: b

Explanation: The vectors which represent rotational effect and act along the axis of rotation in accordance with right hand screw rule are called axial vector. Axial vector will have its direction along its axis of rotation depending on its anticlockwise or clockwise rotational effect.

45. Which of the following variable is discontinuous ?

(A) Time of flight of an aircraft

(B) Life time Of bulbs produced in a factory

(C) Number of individuals in a factory

(D) Time of run of a bus.

ANS: C

46. The value of "C" of Lagrange's mean value theorem for the. function

$f(1) = 2$

$f(x) = x^2$ where $1 < x < 2$

$f(2) = 1$, in the initial (1,2) is

(A) 1

(B) 0

(C) - 1/2

(D) None of the above.

ANS: C

47. The harmonic mean of the data given in table is

No. of students	**Marks obtained**
5	10
8	20
12	30
5	40

(A) 5 students

(B) 7 students

(C) 40 marks

(D) None of the above.

ANS: D

48. The following table gives the frequency distribution of marks obtained by a batch of 20 students:

Marks obtained	Number of students
5	5
15	4
25	6
35	3
45	2

The mean and standard deviation will be respectively.

(A) 21.5, 12.7

(B) 22.5, 14.7

(C) 22.5, 10.7

(D) 21.5, 18.0.

ANS: A

49. A number 864.32 is correct to five significant figures. The relative error will be

(A) $> 1/(4 \times 10^2)$

(B) $> 1/(4 \times 10^4)$

(C) $< 1/(8 \times 10^4)$

(D) $< 1/(8 \times 10^6)$

ANS: C

50. The maximum value of sinx (1 + cos x) occurs at

(A) $x = \pi$

(B) $x = \pi/2$

(C) $x = \pi/3$

(D) $x = \pi/4$

ANS: C

51. If x and y are two real variables such that x >0 and xy=1. The minimum value of (x+y) is

(A) Zero

(B) 1

(C) 2

(D) 4.

ANS: C

52. If the square of x varies as the cube of y and x=3 when y=4,the value of y when x =1/√6 will be

(A) 1/3

(B) √6

(C)1/√6

(D) 2/3

AND: D

53. A candidate obtained the following percentage of marks in the examination:

English	60
Language	65
Mathematics	92
Physics	74
Chemistry	55

The weights allotted to the subjects are 1,2,1, 3, 3 the candidates weighted mean would be

(A) 63.7

(B) 79.2

(C) 71.8

(D) 72.9.

ANS: D

54. The series $\sum 1/n^{p-1}$ is

(A) divergent if $p > 1$

(B) divergent if $p = 1$

(C) convergent if $p > 1$

(D) convergent if $p < 0$.

ANS: C

55. The differential equation

$t^2 y''(t) + t\,y'(t) + (t^2 + n^2)\,y(t) = 0$

is called

(A) Fourier's equation

(B) Laplace equation

(C) Bessel's equation of index n

(D) Hamiltonian equation.

ANS: C

56. When $f(x) = (1-x) / (1+x)$, then $f(1/x)$ equals

(A) $f(x)$

(B) $f(-x)$

(C) $-f(x)$

(D) $\pm f(x)$.

ANS: C

57. If for the function $y=f(x)$ at a point is zero, d^2x / dy^2 is zero and d^3x / dy^3 is non-zero, then the point is

(A) a point of maxima

(B) a point of minima

(C) a point of inflection

(D) none of the above.

ANS: C

58. Given that the area of a figure varies as square of mean ordinate the area of the figure is 154 sq.cm. when the mean ordinate is 7. The area of the figure, when mean ordinate measures 10.5 cm, will be

(A) 346.5 cm^2

(B) 364.5 cm^3

(C) 356.3 cm^2

(D) 364.9 cm^2.

ANS: A

59. As an object approaches the speed of light, it's mass becomes

____

a) Zero
b) Double
c) Remains Same
d) Infinite

ANS: D

60. If the sun radiates energy at the rate of 4 x 10^{26} Js^{-1}, what is the rate at which its mass is decreasing?
a) 5.54 x 10^9 kgs^{-1}
b) 4.44 x 10^9 kgs^{-1}
c) 3.44 x 10^9 kgs^{-1}
d) 2.44 x 10^9 kgs^{-1}

Answer: b
Explanation: As we know from Einstein's mass energy relation, $E = mc^2$.
Therefore, $\Delta E = \Delta mc^2$
$\Delta E = 4 \times 10^{26}\ Js^{-1}$, $c = 3 \times 10^8\ ms^{-1}$.
$\Delta m = 4 \times 10^{26}\ Js^{-1} / 9 \times 10^{16} m^2 s^{-2}$
$\Delta m = 4.44 \times 10^9\ kgs^{-1}$.

61. The orbit of mercury is changing slightly due to the sun's gravity.
a) True
b) False

Answer: a

Explanation: According to Einstein's theory of relativity, a massive object distorted space and time. Thus, due to the curvature of space-time around the massive sun, the orbit of mercury is shifting gradually over time.

62. According to Einstein's Special Theory of Relativity, laws of physics can be formulated based on ____________
a) Inertial Frame of Reference
b) Non-Inertial Frame of Reference
c) Both Inertial and Non-Inertial Frame of Reference
d) Quantum State

Answer: a

Explanation: One of the postulates of Einstein's Special Theory of Relativity states that all the inertial frames are equivalent to the formulation of laws of physics. Thus, it is suitable for all the inertial frames.

63. A frame of reference has four coordinates, x, y, z, and t is referred to as the______________
a) Inertial frame of reference
b) Non-inertial frame of reference
c) Space-time reference
d) Four-dimensional plane
Answer: c
Explanation: Such a frame, having four coordinates of x, y, z and time t is called the space-time frame. It plays a major role in Einstein's special theory of relativity.

64. A man, who weighs 60 kg on earth, weighs 61 kg on a rocket, as measured by an observer on earth. What is the speed of the rocket?
a) 2.5×10^8 m/s
b) 2.5×10^7 m/s
c) 5.5×10^7 m/s
d) 5.5×10^8 m/s

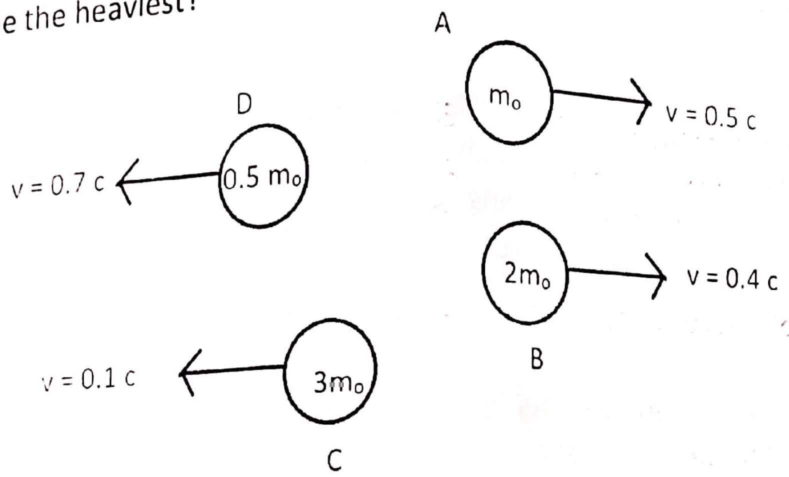
ANS: C

65. The momentum of a photon having energy 1.00×10^{-17} J is ________

a) 2.33×10^{-26} kg m/s
b) 3.33×10^{-26} kg m/s
c) 4.33×10^{-26} kg m/s
d) 5.33×10^{-26} kg m/s

Answer: b
Explanation: Now, the rest mass of a photon is zero.
Therefore, it's momentum, $p = E/c$
$= 1.00 \times 10^{-17}/3 \times 10^{8}$
$= 3.33 \times 10^{-26}$ kg m/s.

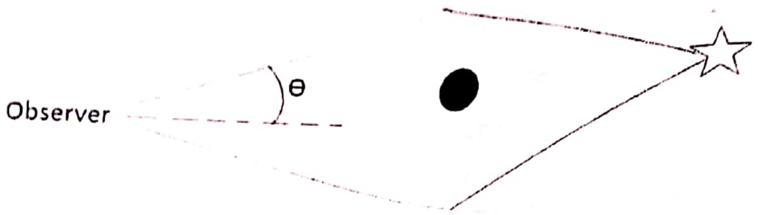
66. According to Einstein's special theory of relativity, which of these objects should be the heaviest?



a) A b) B
c) C d) D

Answer: c
Explanation: As we know, $m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}}$
Using this formula on all of the objects we get.
For object A: m = 1.127 m_0
For object B: m = 2.197 m_0
For object C: m = 3.034 m_0
For object D: m = 0.70 m_0
Hence, Object C has the highest mass.

67. Which effect is shown by the following figure?



a) Gravitational Redshift
b) Gravitational Blueshift
c) Gravitational Lensing
d) Gravitational force

Answer: c

Explanation: Gravitational lensing refers to the distribution of matter between the light source and the observer such that it can bend the light coming from the source to the observer. According to Einstein's theory of special relativity, it happens because a massive object can alter the space-time frame around itself.

68. What will be the output of the following Python code?

```
x = ['ab', 'cd']
for i in x:
    i.upper()
print(x)
```

a) ['ab', 'cd']
b) ['AB', 'CD']
c) [None, None]
d) none of the mentioned

Answer: a

Explanation: The function upper() does not modify a string in place, it returns a new string which isn't being stored anywhere.

69. What will be the output of the following Python code?

```
x = ['ab', 'cd']
for i in x:
    x.append(i.upper())
print(x)
```

a) [‘AB’, ‘CD’]
b) [‘ab’, ‘cd’, ‘AB’, ‘CD’]
c) [‘ab’, ‘cd’]
d) none of the mentioned

Answer: d
Explanation: The loop does not terminate as new elements are being added to the list in each iteration.

70. What will be the output of the following Python code?

```
i = 1
while True:
    if i%2 == 0:
        break
    print(i)
    i += 2
```

a) 1
b) 1 2
c) 1 2 3 4 5 6 ...
d) 1 3 5 7 9 11 ...

Answer: d
Explanation: The loop does not terminate since i is never an even number.

71. What will be the output of the following Python code?

```
>>> str1 = 'hello'
>>> str2 = ','
>>> str3 = 'world'
>>> str1[-1:]
```

a) olleh
b) hello
c) h
d) o

Answer: d
Explanation: -1 corresponds to the last index.

72. Which of the following commands will create a list?
a) list1 = list()
b) list1 = []
c) list1 = list([1, 2, 3])
d) all of the mentioned
ANS: D

73. What will be the output of the following Python code?

```
d = {"john":40, "peter":45}
d["john"]
```

a) 40
b) 45
c) "john"
d) "peter"

Answer: a
Explanation: Execute in the shell to verify.

74. What will be the output of the following Python code?

```
>>>my_tuple = (1, 2, 3, 4)
>>>my_tuple.append( (5, 6, 7) )
>>>print len(my_tuple)
```

a) 1
b) 2
c) 5
d) Error
Answer: d
Explanation: Tuples are immutable and don't have an append method. An exception is thrown in this case.

75. What will be the output of the following Python code?

```
numberGames = {}
numberGames[(1,2,4)] = 8
numberGames[(4,2,1)] = 10
numberGames[(1,2)] = 12
sum = 0
for k in numberGames:
    sum += numberGames[k]
print len(numberGames) + sum
```

a) 30
b) 24
c) 33
d) 12

Answer: c
Explanation: Tuples can be used for keys into dictionary. The tuples can have mixed length and the order of the items in the tuple is considered when comparing the equality of the keys.

76. How many keyword arguments can be passed to a function in a single function call?
a) zero
b) one
c) zero or more
d) one or more

Answer: c
Explanation: Zero keyword arguments may be passed if all the arguments have default values.

77. What will be the output of the following Python code?

```
odd [illegible] (x% )
numbers [n [illegible] n [illegible] nge( )]
[illegible] (numbers)
n [illegible]
[illegible] i [illegible] numbers
    odd(i):
        [illegible]
    [illegible]:
        [illegible]
```

a) [0, 2, 4, 6, 8, 10]
b) [0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
c) [1, 3, 5, 7, 9]
d) Error

Answer: b

Explanation: The code shown above returns a new list containing whole numbers up to 10 (excluding 10). Hence the output of the code is: [0, 1, 2, 3, 4, 5, 6, 7, 8, 9].

78. The command which helps us to reset the pen (turtle):
a) turtle.reset
b) turtle.penreset
c) turtle.penreset()
d) turtle.reset()

Answer: d

Explanation: The command turtle.reset() helps us to reset the pen. After the execution of this command, we get a blank page with an arrow on it. We can then perform any desired operation on this page.

79. Which of the following functions does not accept any arguments?
a) position
b) fillcolor
c) goto
d) setheading()

Answer: a

Explanation: The functions fillcolor(), goto() and setheading() accept arguments, whereas the function position() does not accept any arguments. The function position() returns the current position of the turtle.

80. The function re.error raises an exception if a particular string contains no match for the given pattern.

a) True

b) False

Answer: b

Explanation: The function re.error raises an exception when a string passed to one of its functions here is not a valid regular expression. It does not raise an exception if a particular string does not contain a match for the given pattern.

Don't Stress

Do your best.

Forget the rest.

* * *

We Wish You Best Of Luck For Your PIEAS MS Physics Test 2021